FRUITS AND VEGETABLES

VOLUME 1

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v.1

PART I—FRESH AND DRIED FRUITS
PART II—FRESH AND DEHYDRATED VEGETABLES
PART III—IRISH POTATOES
PART IV—ONIONS
PART V—QUICK FROZEN FRUITS AND VEGETABLES

QUARTERMASTER
FOOD AND CONTAINER INSTITUTE
FOR THE
ARMED FORCES

MILITARY PLANNING DIVISION
OFFICE OF THE QUARTERMASTER GENERAL

VOLUMES IN THIS SERIES

Volume I	Fruits and Vegetables
Volume II	Food Preparation
Volume III	Safekeeping of Subsistence
Volume IV	Processed Foods
Volume V	Dairy Products
Volume VI	Livestock Marketing and Fresh Meats
Volume VII	Processed Meats
Volume VIII	Cereal Products
Volume IX	Flavors, Beverages, and Condiments
Volume X	Fats and Oils

VOLUME I

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PART I—FRESH AND DRIED FRUITS

PART II—FRESH AND DEHYDRATED VEGETABLES

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PART IV—ONIONS

PART V—QUICK-FROZEN FRUITS AND VEGETABLES

First Edition
1 May 1946

Subsequent to submission of the text material for publication the QMC Subsistence Research and Development Laboratory was redesignated the Quartermaster Food and Container Institute for the Armed Forces.

CHARLES S. LAWRENCE
Col., Q.M.C.
Commanding
Quartermaster Food and Container
Institute for the Armed Forces.

PART I

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FRESH AND DRIED FRUITS

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FOREWORD

The importance of fruits and vegetables in the diet is too well-known and recognized to need any lengthy explanation or comment. Briefly, from the health standpoint alone, fruits and vegetables cannot be eliminated from any diet without disastrous results. And as health is the prime requisite of any soldier, the importance of fruits and vegetables cannot be overemphasized in the planning of the soldier menu.

The first four parts of this manual describe the many and varied kinds of fruits and vegetables, the proper selection thereof for Army use, their care, handling, and preparation in the Army mess. A chapter is devoted to fresh fruits, items which should be made available to Army mess at every opportunity. Another chapter deals with dried or dehydrated fruits, which are of extreme importance to the Army in time of war because of the conservation of shipping and storage space and year-round availability.

Similar chapters treat of fresh and dehydrated vegetables. The value of vegetables in the diet as sources of vitamins and minerals is well-known and in addition they furnish the bulk and roughage necessary to a well-balanced meal. Attention long has been focused, particularly in war emergencies, upon dehydrated foods, and the experiences of World War II renewed the activity in this field of endeavor and resulted in the production of foods that were tasty, tender, and of high acceptance. Through research and study, soldiers were supplied dehydrated foods which reconstituted in the shortest practical period of time, cooked without becoming mushy or disintegrated, retained their original flavor and color, withstood storage requirements, retained essential vitamin and mineral content, and, through good packaging, withstood contamination from outside sources.

Full discussion is given to those staple bulwarks of all vegetables, the Irish potato and the onion.

A final chapter is devoted to a discussion of the comparatively new and immensely popular item, quick-frozen foods. Efforts of the Quartermaster Corps in World War II to provide varied and popular items brought into sharp focus quick-frozen foods, a processed item which brings the product, despite long periods of storage and miles of shipping, garden-fresh to the soldier mess. The popularity of quick-frozen foods has carried on to public favor and the development of the industry in civilian channels has grown by leaps and bounds. Quick-frozen foods bid to become a standard item of supply for all time to come.

1 February 1946

ROHLAND A. ISKER,
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Development Laboratory

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CHAPTER ONE

FRESH FRUITS

SECTION I

INTRODUCTION

1. GENERAL.—*a.* Fresh fruit has been a component of the human diet throughout the ages. With few exceptions, before the middle of the nineteenth century, wild fruits were gathered as they ripened, and, of course, were eaten only in season. Today, with our facilities for refrigeration and transportation, we can enjoy all fruits the year round and benefit from their regulatory properties, their minerals, and their vitamins. The development of pomology—the science and practice of fruit growing—has produced a fruit industry of tremendous proportions. Studies in proper growing conditions, selective propagation, and natural and artificial crossing have resulted in improved varieties which sometimes bear little resemblance in size, color, and flavor to the wild parent plants or fruits.

b. Fruits undergo marked changes as they ripen. They grow in size, and their colors change from raw green to their characteristic ripe colors. Because the complex compounds which produce these ripe colors are not stable, many fruits lose color when they become overripe. Two other outstanding characteristics of fresh fruits are their aromas and their flavors. The aromas are produced by certain ethereal bodies, while most of the flavors are produced by sugars and acids. Both aromas and flavors may be impaired or destroyed by overmaturity.

c. Aside from price, the average consumer's choice of a particular fruit is influenced primarily by appearance. However, appearance is not always an indication of good quality. A fruit of very attractive appearance may have poor quality because of varietal characteristics or because of some such internal condition as overmaturity. On the other hand, a fruit with poor skin or other surface blemishes may have fine eating qualities.

d. Because fresh fruits are living plants, they require great care in handling, and proper temperature and humidity while they are stored.

2. PURPOSE AND SCOPE.—Army personnel responsible for procuring and handling fresh fruits should be familiar with varieties, diseases, growing seasons, markets, trade terms, grades, inspection, packing, storage, and prices of the various fruits. These topics are briefly treated in this text. Its purpose is to guide army personnel in the procurement of fruits which meet army requirements.

SECTION II

POME FRUITS

3. APPLES.—The apple tree, essentially a temperate-zone plant, produces its best fruit in regions having cool summers and not too severe winters. Cultivation has greatly improved the apple from its original form—the crab apple, a small, acid, almost inedible fruit—to a popular well-flavored, nutritious fruit.

a. Varieties.—No other cultivated fruits or vegetables produce so many varieties as the apple. More than eight thousand varieties have already been reported. Apple varieties are frequently classified as summer, fall, and winter. The summer varieties mature during June, July, and early August; the fall varieties, during late August, September, and early October; and the winter varieties, during late October, November and December. Summer apples, as a rule, keep poorly and should be marketed within a short

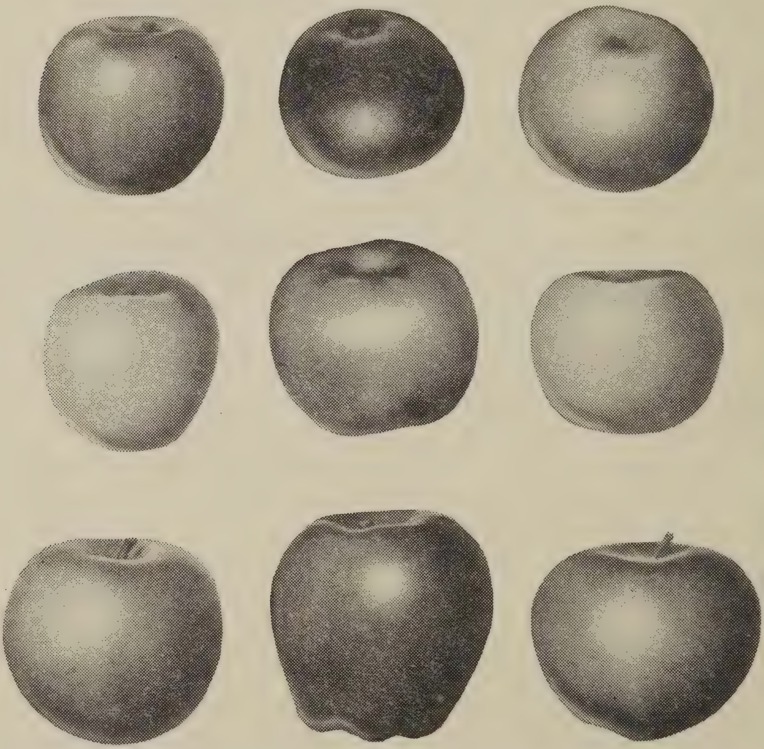


Figure 1.—Common apple varieties, left to right, top to bottom: Jonathan, Baldwin, Stayman, Yellow Newtown, York Imperial, Grimes Golden, Rome Beauty, Delicious, Winesap.

time after they are harvested. Under favorable storage conditions, fall apples may be held from 1 to 4 months, and winter apples from 4 to 6 months. Table I lists the most important varieties grown in the apple-growing regions of the United States.

b. Maturity.—The apple harvest for the United States generally extends from June to November. The date varies somewhat from season to season, depending on the weather conditions. Immature, partly colored apples are poor in texture and quality, tend to wilt and scald, and offer little resistance to decay. Overmature apples become mealy and lack firmness and keeping quality. The maturity of apples may be determined by inspecting the fruit for the following changes:

TABLE I—CHARACTERISTICS OF LEADING APPLE VARIETIES

Variety	Locality	Main market season	Size of fruit	Color of fruit	Flesh	Dessert quality	Cooking quality	Cold storage season		Tendency to storage scald
								Normal days (1)	Maximum days (2)	
Arkansas Black	Washington, Oregon, Illinois, Missouri	Nov. to May	Medium to large	Medium to dark red	Firm, crisp, juicy, slightly acid	Fair	Good	120 to 150	180	Severe
Baldwin	New York, New England, Michigan	Nov. to Apr.	Medium to large	Medium red	Hard, crisp, juicy, medium acid	Fair	Good	120 to 150	180 to 200	Medium to severe
Ben Davis	New England, New York, Cumberland-Shenandoah area, Middle West, Colorado	Nov. to June	Medium to large	Striped medium red	Hard, dry, tough, medium acid	Poor	Fair	120 to 150	240	Medium
Delicious	Washington, Middle West, Cumberland-Shenandoah area	Oct. to Apr.	Medium to large	Medium red	Crisp, juicy, mealy when overripe, low acid	Excellent	Poor	90 to 120	180	Slight
Esopus Spitzenburg	Northwest	Oct. to Feb.	Medium to large	Bright red	Firm, crisp, tender, medium acid	Excellent	Good	90 to 120	150	Slight
Gravenstein	California, New England	July to Sept.	Medium	Striped bright red	Firm, crisp, juicy, medium to high acid	Good	Excellent	0 to 30	90	Slight
Grimes Golden	Cumberland-Shenandoah area, Middle West	Sept. to Jan.	Medium to small	Yellow	Crisp, juicy, medium tender, medium acid	Good to excellent	Good	60 to 90	120	Severe
Jonathan	Middle West, Washington, Idaho, Colorado	Oct. to Jan.	Medium to small	Bright red	Tender, crisp, juicy, medium to high acid	Excellent	Good	60 to 90	120	Slight
McIntosh	New England, New York, Michigan, Montana	Oct. to Jan.	Medium	Medium red	Hard, crisp, juicy, medium acid	Excellent	Good	60 to 90	120 to 150	Severe
Northern Spy	New York, New England, Pennsylvania, Michigan	Oct. to Mar.	Large	Striped bright red	Firm, crisp, tender, juicy, medium acid	Excellent	Excellent	120 to 150	180	Slight
Oldenburg (Duchess)	Michigan, Illinois, New York, New Jersey	Aug. to Oct.	Medium	Striped medium red	Firm, juicy, high acid	Poor	Good	0 to 30	90	Slight
R. I. Greening	New York, New England, Michigan	Oct. to Mar.	Medium to large	Green yellow	Firm, juicy, medium to high acid	Good	Excellent	90 to 120	180	Severe
Rome Beauty	Washington, Oregon, Idaho, Ohio, West Virginia	Nov. to May	Large	Medium red	Firm, crisp, mealy when overripe, medium to low acid	Fair	Good	120 to 150	180 to 210	Medium
Stayman Winesap	Cumberland-Shenandoah area, Ohio, Washington	Nov. to Apr.	Medium to large	Medium red	Firm, juicy, medium acid	Excellent	Excellent	120 to 150	150 to 180	Medium to severe
Wagener	Michigan, New York	Nov. to Jan.	Medium	Bright red	Firm, juicy, medium acid	Good	Good	90 to 120	120 to 150	Severe
Wealthy	New Jersey, Middle West, New York, New England	Oct. to Dec.	Medium	Medium red	Firm, juicy, medium acid	Excellent	Good	0 to 30	90	Slight
Winesap	Washington, Virginia, Illinois	Jan. to May	Small to medium	Dark red	Hard, crisp, juicy, medium acid	Good	Good	150 to 210	240	Medium
Winter Banana	Washington, Oregon	Sept. to Nov.	Medium to large	Yellow red blush	Firm, tender, medium to low acid	Fair	Fair	90 to 120	150	Slight
Yellow Newtown	Virginia, Washington, Oregon, California	Jan. to May	Medium	Yellow	Hard, crisp, juicy, medium to high acid	Excellent	Good	150 to 180	240	Slight
Yellow Transparent	Illinois, Tennessee, Delaware, West Virginia	July to Aug.	Small to medium	Yellow	Medium tender, juicy, very high acid	Poor	Good		90	None

(1) Represents the time most of the fruit may be safely held.
(2) Represents the maximum period for safe holding of fruit picked handled, and sorted under the best conditi

(1) Yellowing of the unblushed color of the apple.

(2) Softening of the flesh of the apple.

(3) Development of the blush color on red or blushed varieties.

(4) Browning of the apple seeds. Although the degrees of red color and the browning of the seeds are used to some extent in determining maturity, they are not always reliable indicators.

c. Preparation for packing.—Apples usually pass through several steps from the time they are picked until they are packed. In the orchard the apples are emptied from the picking containers into field boxes or crates, which hold about a bushel, and are brought to the packing house. There they are washed with a dilute acid solution to remove spray residue and to improve their appearance. After they are graded and sorted, they are packed for market.

d. Packaging.—(1) Apples are packaged in boxes, bushel baskets, or barrels. A box is generally considered equivalent to a bushel, and a barrel equivalent to 3 bushels. The weight of a bushel of apples depends on the variety, size, tightness of the pack, and the measure (whether heaped or level). The average net weight is figured at 48 pounds.

(2) The western box (10½ by 11½ by 18 inches inside dimensions) contains about 23 cubic inches more than a level or struck bushel. In addition to its use in the Western States, this box is used in Ohio, Georgia, and the New England States. A popular container in the New England States is the New England lug box, measuring 7$\frac{1}{16}$ by 17½ by 17½ inches inside dimensions.

(3) The bushel basket now in general use is the straight-side or tub type, as distinguished from the round or curved-bottom type formerly used. The popularity of the bushel basket is due to its ease in handling, convenient size, and uniform pack. Bushel baskets of apples should be staggered so that there is no bruising pressure in the center of the lids.

(4) Some of the different packages and their cubage are as follows:

Packages	*Cubage (Inches)*
Winchester bushel (adopted 1836)	2,150.42
Round stave basket	2,150.42
Bushel (U. S. Bureau of Standards)	2,150.42
Boston bushel box	2,163.00
Standard western apple box	2,173.56
New England apple crate	2,618.00
Slat crate (lug box)	2,700.00
Standard apple barrel (3 bushels)	7,056.00

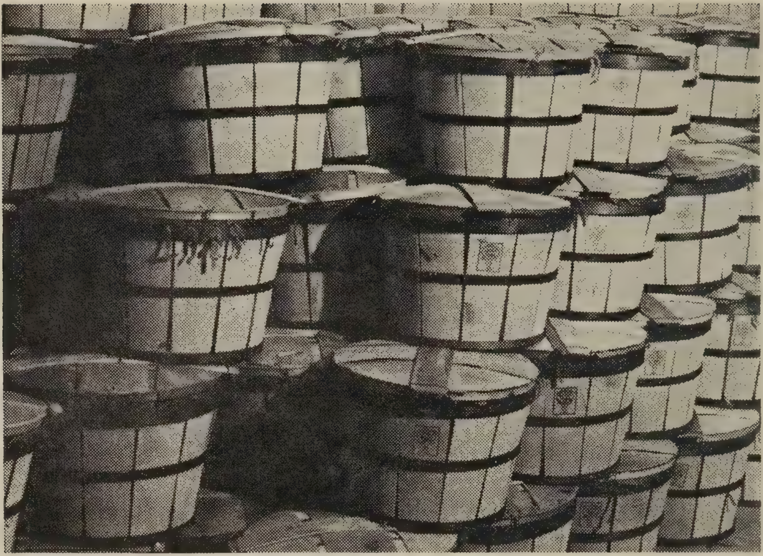


Figure 2.—Staggering bushels in stacking.

e. Apple sizes.—The size of the apples in the box pack is indicated by the numerical count. Extremely large apples may be packed 36 to the box; and extremely small ones, 252 to the box. Apples packed 88 or less are classed as very large; those from 96 to 125 inclusive, as large; those from 138 to 163, as medium; those from 175 to 200, as small; and those packing 216 or more, as very small. The size of the apples in a basket or a barrel is indicated by the diameter of the smallest apple in the container, expressed in terms of inches, half inches, and quarter inches. A range may be specified indicating minimum and maximum sizes of the apples in the container, as 2½ to 2¾ inches. Packages are generally stamped with the grade, size, and variety of the contents.

f. Storage.—(1) To insure soundness and good keeping quality, apples must be properly grown, picked at their optimum stage of maturity, and so handled during harvesting, packing, and storage that they are not bruised or punctured. Apples should be held at a temperature which is uniform and as low as possible without freezing. Apples remain crisp and juicy much longer when stored at temperatures ranging from 32° to 40° F. The relative humidity of the storage room should be about 85 percent in order to check dehydration and prevent shriveling. However, apples should not be stored where moisture condenses on the surface of the fruit, for excess moisture will induce the development of rot.

(2) Apples should not be stored in the same room with products which give off-odors because such odors may be absorbed.

g. Diseases and defects.—Apples are highly susceptible to disease and attack by worms and insects. The more common diseases are identified as alternaria rot, apple cedar rust, blue-mold rot, and apple scab. The apple maggot and the codling moth cause the worst of the insect injuries. The apple is also subject to defects of a physiological nature, such as bitter pit, internal breakdown, scald, water core, and to freezing injury. In general, the diseases and insect injuries may be controlled by spraying the trees and apples with specific insecticides or fumigants.

(1) *Alternaria rot,* a fungus disease, occurs almost wholly on apples stored at cool temperatures. It is characterized by firm, slightly sunken, decayed areas which are most commonly dark brown to black. Control of this fungus depends on careful handling during the processes of picking, washing, and packing.

(2) *Blue-mold rot* is the most common and usually the most destructive of all the rots found on apples in storage or on the market. The rot appears as soft, watery spots of a light-brown to pale straw color, and may be found on any part of the fruit. Moisture, moderately high temperature, and skin breaks are conducive to the development and spread of blue-mold rot in storage.

(3) *Apple scab* is distinguished by small patches of thickened, corky tissue of a greenish-black or sooty color. High temperature and humidity favor the spread of apple scab in storage.

(4) *Bitter* pit is a physiological disease which occurs in all apple-growing regions. It is characterized by sunken spots dispersed over the blossom end of the apple. Although the development of bitter pit is retarded by storage at 32° F., it will develop rapidly on immature fruit after removal from such storage.

(5) *Scald* is a very common defect in apples. It is confined to the skin and does not affect the quality of the fruit, although the appearance is injured. Scald is caused by the accumulation within the apple tissues of certain gases that are produced by the apples as a result of their continual respiratory activity. These gases can be removed by efficient aeration or ventilation. In mild cases the disease appears as a superficial browning of the skin, but in more severe cases the entire skin layer is killed. On immature, poorly colored, or overripe fruit stored in warm temperature scald spreads rapidly. Scald develops more severely in standard commercial barrels than in open packages, such as the box or basket. The most satisfactory and practical method of scald control is the use of shredded oiled paper in packing apples for storage.

(6) *Injuries from exposure to low temperatures* frequently occur. The extent of the injury depends on the length of exposure, the actual temperature of the apples, and the initial condition of the fruit. If freezing has been slight, there may be no marked external symptoms; if it has been severe, the surface becomes discolored and appears considerably darkened. Usually the best indications of freezing injury are found by examining a cross section of the fruit. This injury is evidenced by a brown discoloration extending from the center throughout the flesh. Apples that have been partially frozen are often dry and mealy. Severely frozen apples are usually soft, mushy, and insipid. Frozen apples should be thawed at 35° to 40° F. and must be handled carefully to prevent bruising.

(7) *Internal breakdown,* a disease associated with large and overripe apples, is most serious in summer and early fall apples. It is characterized by a mealy brown condition of the flesh and develops largely during storage. The presence of the disease can usually be detected by the spongy softness of the apple.

(8) *Sunburn injury* to apples is due to late application of spray during hot, bright days. It produces a brown area on the exposed side of the fruit and gives it a burned or baked appearance.

h. Procurement and inspection.—(1) Apples procured for the Army are U. S. Fancy and U. S. No. 1 grades as specified in Federal Specification Y-A-606 for Fresh Apples.

(2) In selecting varieties the purchasing officer should choose from the varieties available at nearby markets. He should purchase those that best meet requirements for size, appearance, flavor, keeping quality, and package.

(3) The most satisfactory sizes for Army use are those apples that pack 125 to 163 per box, or apples 2½ to 3¾ inches in diameter if packed in baskets or barrels. The western box is preferable for the Army, and the bushel basket is second choice. Purchase of apples in barrels should be avoided.

(4) Apples should be carefully inspected before purchase. A representative sample of each delivery should be graded according to the United States Standards for Grades of Fresh Apples, with particular attention directed to firmness, color, flavor, insect disease, and defects caused by external injury.

4. PEARS.—The pear, pyrus communis, is closely related to the apple. It is similar in that the edible part of the fruit is formed from the greatly enlarged end of the flowering stem. It differs from the apple in that the tissue of the pear beneath the rind contains clusters of cells filled with hard, woody, deposits constituting the "grit."

a. Varieties.—Pear varieties are classed according to their harvest season and according to their flesh texture and use. Early varieties are harvested during the late summer and early fall. Late varieties are harvested during the late fall and early winter. Pears used as a dessert, either raw or canned, have a soft, juicy flesh and excellent flavor. Those varieties having crisp, hard flesh are used for preserves or pickling. The "grit" in the latter varieties is much more pronounced and often tends to woodiness. Table II indicates a few of the leading pear varieties, the periods of marketing, and physical characteristics.

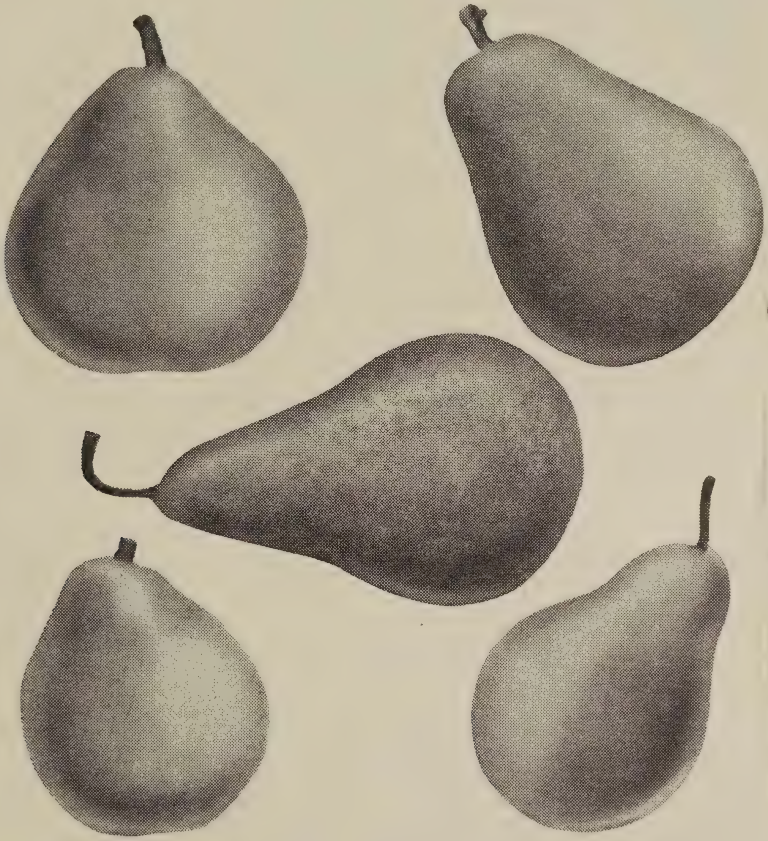


Figure 3.—Common pear varieties: top, Du Comice and Hardy; center, Bosc; bottom, D'Anjou and Bartlett.

b. Maturity.—(1) Pears are usually picked when slightly immature, and are ripened in storage because the fruit ripened in storage possesses a better flavor and texture than that ripened on the tree. Pears stored in rooms at 60° to 65° F. with a relative humidity of 80 percent will ripen within 10 to 12 days. Low storage temperatures retard ripening. Pears that are too green to serve immediately should be ripened by keeping them in the mess kitchen for 1 or 2 days.

(2) At proper maturity pears are firm, free from blemishes, and are not wilted or shriveled. Those that are soft and yield readily to finger pressure at the base of the stem should be used at once and not placed in storage. The maturity and firmness of pears may also be determined by the Magness and Taylor pressure tester. This apparatus measures the force in pounds required to drive a round plunger of a given size to a given depth into the flesh of the pear. Generally, pears testing 11 to 13 pounds are considered to be properly matured and ready for harvesting.

c. *Packaging.*—Pears should be graded prior to packing. If they are to be held in storage, they should be wrapped in paper to prevent shriveling and scald. Pears are usually packed in a standard pear box, 8½ by 11½ by 19¾ inches, which holds from 60 to 245 pears, depending upon the size of the pears.

d. *Storage.*—The optimum storage condition for most pear varieties is a temperature from 29° to 31° F. with relative humidity of 85 to 90 percent and adequate air circulation. The most desirable storage temperature is 31° to 32° F. The commonest and most serious decay of pears in storage is gray-mold rot. This rot can be controlled by use of paper wrappers impregnated with copper. Bartlett and d'Anjou pears exposed to temperatures below their freezing point have a glossy, water-soaked appearance.

e. *Diseases and defects.*—Pears are subject to many of the same diseases and injuries that occur in the apple, *i. e.,* black end, brown rot, internal breakdown, freezing injury, scab, and scald.

(1) Black end of pears is more common in California than elsewhere. The Bartlett variety is most susceptible to the disease, which also occurs in the d'Anjou, Winter Nelis, and Du Comice varieties. The discoloration, blackening of the end of the pear, usually does not penetrate deeply into the flesh.

(2) *Brown rot* seldom causes severe loss. It starts as a rather soft decay which ultimately involves the whole fruit. This is a storage disease that spreads rapidly unless the fruit is placed under refrigeration as soon as possible after harvesting.

(3) *Internal breakdown* is a common defect in most varieties of pears. As in the apple, the disease causes a softening and browning of the tissue in the region of the core. This is a condition that develops during storage. Because the occurrence of internal breakdown depends largely on the maturity of the fruit, overmature pears are readily susceptible to it.

(4) *Freezing injury* develops in pears stored below their freezing point

TABLE II
CHARACTERISTICS OF LEADING PEAR VARIETIES

Variety	Locality	Seasonal Classification	Market Season	Size	Color	Use	General Characteristics
d'Anjou	New York Pacific Coast and Southern States	Late fall and winter	Oct. to Apr.	Large	Yellow	Dessert and canning	Excellent keeping quality
Bartlett	Universal	Early July to late Aug.	July to Oct.	Large	Yellow	Dessert and canning	Best all-purpose pear grown. Medium keeping quality. Susceptible to blight
Bosc	Oregon California, New York	Late Oct. and Nov.	Oct. to Apr.	Large	Yellow and covered with brown russet	Dessert	Good keeping quality; 3 to 4 months in cold storage. Juicy, well-flavored flesh. Subject to blight
Clapp's Favorite	New England, New York	Early Aug.	Aug. to Oct.	Medium	Green to light yellow	Cooking and canning	Poor keeping quality. Subject to blight
Gorham	New York, New England, Pacific Coast	Early Aug.	Aug. to Nov.	Large	Yellow	Dessert and canning	Rivals Bartlett. Resistant to blight
Hardy	California, Middle Atlantic States	Early July to Aug.	July to Dec.	Medium	Green to yellow	Dessert	Good keeping quality
Du Comice	Pacific Coast and Southern States	Late Oct.	Oct. to Mar.	Large	Light greenish yellow	Dessert	Easily bruised, tender skin
Wilder Early	Pacific Coast, New England	Early June	June to Oct.	Small	Yellow with red blush	Dessert	Fine texture and flavor. Fair keeping qualities
Winter Nelis	Pacific Coast New York	Late fall and winter	Oct. to Apr.	Small	Green-yellow with dark brown	Dessert	Excellent keeping quality. Juicy, well-flavored, and tender texture
Seckel	Midwest and Southern States	Late Oct.	Oct. to Apr.	Medium	Yellow	Dessert, canning and pickling	Good flavor and quality
Kieffer	New England, New York, Michigan	Oct. to Dec.	Oct. to Dec.	Medium to large	Yellow	Cooking and canning	Very poor fresh. Good keeping quality

(23° to 27° F.) from 4 to 6 weeks. Fruit so affected is inedible and presents a glossy, water-soaked appearance.

(5) *Pear scab* differs from apple scab in that it produces larger and rougher spots on the fruit. It is most common in Northeastern pear sections.

(6) *Scald* in pear varieties is evidenced by brown or black discoloration. Like apple scald, it occurs more frequently on immature than on mature fruit and is most likely to occur under poorly ventilated storage conditions. Ordinary storage at 31° F. retards the development of scald, whereas storage at 45° F. brings about its development in 30 days. The use of shredded oiled paper in packing pears for storage is the recommended method of control.

f. Procurement and inspection.—(1) Existing regulations require that all fresh pears purchased for army use be equal to or better than those specified in the minimum requirements of the applicable specifications. Federal Specification Y-P-166 for Fresh Pears limits purchases to U. S. No. 1 grade of certain varieties, and to sizes packed—135, 150, or 165 to the standard commercial box, as specified in the invitation for bids.

(2) Pears should be carefully inspected before purchase. Representative samples of each purchase should be graded according to the United States Standards for Grades of Fresh Pears, with particular attention directed to firmness, color, flavor, insect disease, and defects caused by external injuries.

SECTION III

DRUPE OR STONE FRUITS

5. GENERAL.—Stone fruits comprise the apricot, cherry, peach, and plum. Although these fruits have enough in common to be grouped in the same genus, they are quite different in many characteristics. When the fruits are ripe, the flesh of some varieties parts readily from the pit. Such fruits are called *freestone*. In other varieties and species (for example, the canning type of peaches) the flesh adheres to the stone. These are called *clingstone*. The individual fruits may have a smooth skin, as the apricot, plum, and cherry, or a fuzzy or hairy skin, as the peach. The varieties and species vary in size, color, and shape. The flesh may be yellow, green, white, or red, or various combinations of these colors. The stones or pits of the peach are rough and grooved; those of the plum, cherry, and apricot are relatively smooth. Stone fruits are grown in all parts of the United States and are marketed as fresh, canned, frozen, and dried products.

6. APRICOTS.—*a. Varieties.*—The bulk of the apricot crop, produced almost entirely in California, is dried and canned. The varieties most widely produced are the Royal, Blenheim, Moorpark, Hemskirk, Tilton, Peach, and New Castle.

b. Maturity.—Apricots ripen from late May until August, but, because of their perishability, they are often harvested for the fresh market when slightly green. The tree-ripened fruit is plump, fairly firm, juicy, highly flavored, and tender, and has a uniformly golden-yellowish color. Immature apricots have a greenish-yellow color and a hard flesh and are mildly astringent and bitter.

c. Handling.—Apricots must be handled very carefully because they bruise easily, and bruises produce rapid decay. They should be kept cool, dry, and out of the sun, because heat and moisture cause serious spoilage losses. The fruit is marketed in basket crates of about 24 pounds net weight, depending upon the number of fruit packed in the crate. The fruit may be stored from 7 to 10 days under storage conditions of 31° to 32° F. with relative humidity of 80 to 85 percent.

d. Procurement and inspection.—(1) Because fresh apricots of fine quality are expensive, they are not used extensively in army messes. Federal Specification Y-A-621, Fresh Apricots, limits the procurement of fresh fruit to U. S. No. 1 grade.

(2) Fresh apricots should be inspected for worms, skin cracks, and for soft, overripe, decayed, or shriveled fruit.

7. PEACHES.—*a. General.*—Peaches are among our most prized and widely grown fruits. Since the peach is a relatively perishable fruit, and

since the crop is easily damaged by extreme cold, peach orchards are generally confined to regions with fairly moderate climate. California and Georgia produce more than half of the entire peach crop. Peaches are divided into two general classes, clingstone and freestone, depending on whether the flesh adheres to the pit or may be easily separated. Each class has varieties with white or yellow flesh. The freestone varieties are more popular for desserts; the clingstone are better for canning.

b. Varieties.—Peach varieties change rapidly because only a short period is required to develop and test new varieties, and because winter injuries, diseases, and insects kill the trees after comparatively short periods of time. Some of the more popular peach varieties are briefly described in table III.

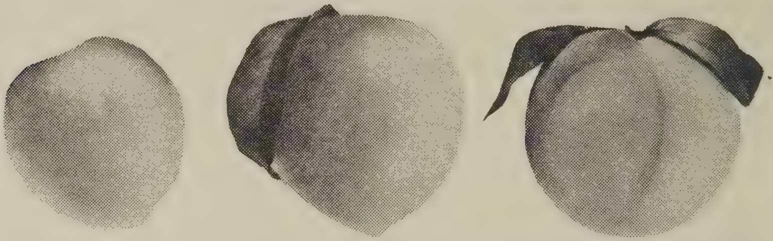


Figure 4.—Common peach varieties: left to right, Hiley, Elberta, Hale.

c. Maturity.—Peaches at the proper stage of maturity should be plump, well-colored, free from blemishes, and should have a firm flesh. The stages of maturity at which peaches should be packed for shipment differ with the variety. For example, the Hiley ripens more slowly than most other early or medium-early varieties, whereas the Elberta matures very rapidly and must be carefully examined to prevent shipment of overmature fruit. Some varieties develop a red blush, but this coloring is not always a sign of maturity. Immature peaches have a pale yellow color, lack flavor, and have a hard, rubbery flesh.

d. Packaging.—(1) Various packages are used in marketing peaches, depending on the fruit varieties, methods of shipment, market conditions, and several other factors. The bushel basket, the 6-basket carrier, the 16-quart and 20-quart hampers, and the western box are the principal containers used in marketing peaches.

(2) The bushel basket is most widely used in the shipment of peaches from the Middle West, western New York, and Texas. It is cheap and can be packed rapidly with the aid of mechanical packing devices. It is an excellent container for the Elberta variety.

(3) The 6-basket carrier, widely used in the Carolinas, is especially suitable for shipping such early peach varieties as Carman, Hiley, and Belle of Georgia. Peaches put up in this package are well protected, receive

TABLE III

CHARACTERISTICS OF LEADING PEACH VARIETIES

Variety	Color of flesh	Size and shape	Stone: cling or free	Maturity date	General characteristics
Elberta	Yellow with red blush	Large and oval	Free	Aug. to Sept.	Excellent shipper
J. H. Hale	Yellow with red blush	Large and round	Free	Aug. to Sept.	Excellent flavor and a good shipper
Halehaven	Yellow and highly blushed	Medium to large round	Free	Aug.	Excellent flavor and very attractive
Golden Jubilee	Yellow with slight blush	Large and oval	Free	Aug.	Juicy and good flavor. Bruises easily
Hiley	White	Medium large	Free	Aug.	Juicy and good flavor
Cumberland	White and heavily blushed	Large bell-shaped	Free to semi-cling	July and Aug.	Very good flavor and quality
Carman	White	Medium to large	Free to semi-cling	Aug.	Good quality

careful handling in packing, and are attractively displayed. The carrier contains six 4-quart till baskets and holds from 108 to 306 peaches, depending upon the size of the peaches.

(4) The 16-quart and the 20-quart hampers are used in the Middle Atlantic States, particularly New Jersey and Delaware.

(5) The western box is used in shipping fresh peaches from California and the Northwest States. Its inside dimensions are 11½ inches wide by 18 inches long by 4 to 4¾ inches deep. The box is always lidded and offers good protection to the fruit. The western box holds from 32 to 96 peaches packed in two layers. The number of peaches varies according to the number of rows and the number of peaches in each row. A packed box is estimated at 21½ pounds gross. A minimum carload weighs 28,000 pounds. Peaches are usually wrapped in tissue paper prior to packing to reduce bruising and to check the spread of decay. All peach containers should be so packed that the tops will bulge when nailed on. This tight packing prevents the fruit from shifting and bruising during shipment.

e. Diseases and insect pests.—Peaches are readily susceptible to attack by micro-organisms and insects. Some of the more common diseases are known as brown rot, scab, Coryneum blight, and bacterial spot. Certain peach virus diseases, including peach yellow, little peach, and red suture, are also important.

(1) *Brown rot* is the most serious fruit rot of the peach. This fungus infection causes loss during shipment and in storage. It begins as a small brown rotted spot which enlarges rapidly, especially on ripe peaches, until the whole fruit is affected. The control of brown rot depends primarily on sulfur sprays or dusting.

(2) *Peach scab,* a fungus disease, causes black shallow spots which detract from the appearance, quality, and value of the fruit. Because the tissue beneath such a fruit spot does not make a normal growth, cracks develop in the flesh allowing other fungi, especially brown rot, to enter. Control is the same as for brown rot.

(3) *Coryneum blight* is caused by a fungus which damages the peach tree and the fruit. The spots on the fruit are characterized by a bright-red border and a cream-colored center. Effective control is obtained by spraying the trees.

(4) *Bacterial spot* is a disease which shows first as small brown spots. As the disease progresses, affected tissues dry and crack, the cracks becoming so marked in later stages that they sometimes make the fruit inedible. Effective control is obtained by spraying the trees.

(5) *Little peach* can be identified by its small, late-ripening, worthless fruit. The foliage is clustered and, in the later stages of the disease, is off-colored and yellow.

(6) *Red suture* is characterized by a premature ripening of the suture side of the peach, frequently accompanied by a rough or bumpy surface.

(7) *Insect pests,* such as plum curculio, oriental fruit moth, fruit-tree leaf roller, and thrips, attack peaches and render them unsatisfactory for marketing and storage. Control is dependent on the application of proper insecticides.

f. Storage.—In general, peaches may be stored for 3 to 4 weeks under optimum conditions of 31° to 32° F. and 80 to 85 percent relative humidity. The best varieties of peaches for storage and their maximum storage periods are as follows:

Varieties	*Storage periods (weeks)*
J. H. Hale	4
Halehaven	4
Elberta	3 to 4
Cumberland	2 to 3
Hiley	2 to 3
Carman	2 to 3

Prolonged storage results in loss of flavor and natural bright color; the flesh becomes mealy or mushy and is likely to develop rot.

g. Procurement and inspection.—(1) Peaches procured for Army use should comply with Federal Specification Y-P-151, and purchases should be limited to U. S. No. 1 grade and to certain specified varieties.

(2) Peaches should be carefully examined for worms and decay, which may be detected by small punctures in the skin from which gum exudes. Sometimes it may be necessary to cut the peach for proper examination. The detection of only a few wormy peaches in a lot is ground for rejection of the lot. Decay usually appears in the form of brown circular spots which spread very rapidly and often destroy the whole fruit.

8. PLUMS.—*a. Varieties.*—(1) The important plum regions are in the Northeastern States, in sections along the Great Lakes, and in the Pacific Coast States. Plum varieties may be classified according to their color, as follows:

Purple or blue:
  Italian Prune Plum
  Damson

Red:
  Clayman
  Bradshaw
  Climax
  Hungarian
  Santa Rosa

Yellow or green:
  Yellow Egg
  Beauty
  Wickson
  Kelsey
  Green Gage

(2) The largest plum is the Yellow Egg which is often 2 inches in length, while the smallest is the Black Damson, some types of which are no larger than a good-sized cherry. The Green Gage plum is a very popular variety for both canning and dessert, for it has a fine flavor and sweet, juicy flesh. Plums of the Damson variety are good for jams and jellies because of their tart flavor.

b. Maturity.—Mature plums of good quality are plump, firm, full-colored for their variety, and soft enough to yield to slight pressure. Color alone cannot be relied upon as an indication of ripeness. Some varieties are full ripe when their color is yellowish-green, and others when their color is purplish-blue or black. A softening at the tip of the plum is generally a good indication of proper maturity for marketing.

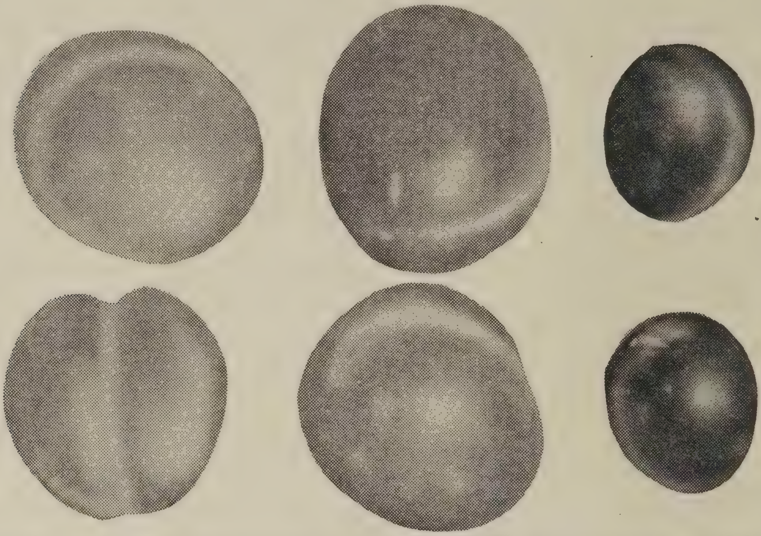


Figure 5.—Common plum varieties: left to right, Wickson, Santa Rosa, prunes.

c. Storage.—(1) Plums cannot be stored for long periods. Good fruit may be kept for 1 week under optimum storage conditions. *i. e.,* 31° to 32° F. with relative humidity of 80 to 85 percent. After 2 weeks at 32° F., all varieties become overripe and lose their flavor. Italian plums stored for 3 weeks develop internal breakdown and off-flavor.

(2) Plums should be used as soon as possible after market delivery or removal from storage; for, although they may have a fine appearance during storage, decay and internal browning may develop shortly after removal from storage.

d. Procurement and inspection.—(1) Fresh plums purchased for the Army must meet the minimum requirements of Federal Inspection Y-P 506 which limits purchases to U. S. No. 1 grade and to certain specified varieties.

(2) In inspecting fresh plums, care should be taken to accept no sof or shriveled fruit. Samples should be graded in accordance with the United States Standards for Grades of Fresh Plums.

9. CHERRIES.—*a. General.*—The cherry is another stone fruit that is grown very widely. Cultivated cherries are classified as sweet or sour. Sweet cherries are used principally as dessert, and sour cherries are used for pies, preserves, and sauce. Although cherries are grown in nearly every home garden, commercial production of sweet cherries is confined primarily to California, the Pacific Northwest, and the Great Lakes regions. Sour cherries are produced chiefly in New York, Michigan, and Wisconsin.

b. Varieties.—Table IV lists the most popular varieties of sweet and sour cherries with their characteristics.

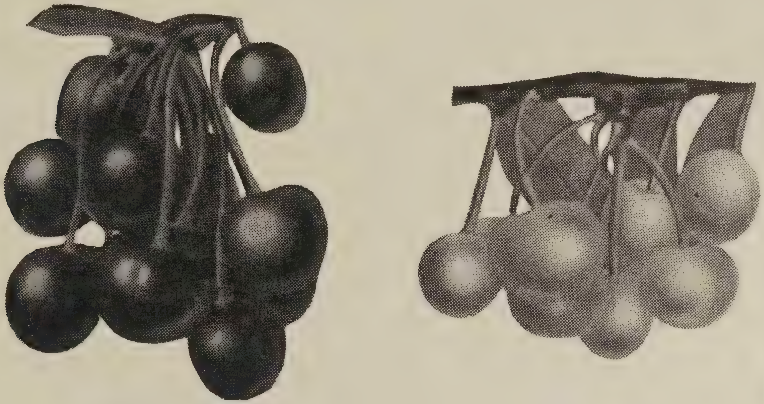


Figure 6.—Cherries: left, Tartarian; right, Royal Anne.

c. Maturity.—The cherry season extends from early June to the middle of August. Cherries at proper maturity are of good size for the particular variety, fairly firm, well-colored, juicy, and highly flavored. Immature cherries have a peculiar bitter tang, and are undesirable.

d. Packaging.—Cherries are marketed in pint and quart baskets, 16, 24, or 32 to the crate. In Western areas, sweet cherries are packed for shipment in 8- or 10-pound boxes or flats. Some shipments are made in small lugs holding 16 pounds net of loose-packed cherries.

e. Storage.—Sweet or sour cherries are rarely stored for long periods because of the resulting loss of flavor and color, and because of their generally unattractive appearance. Keep cherries out of sunny or drafty places and do not sprinkle. Sun, wind, and moisture cause spoilage. Sweet varieties may be stored for 3 or 4 weeks, and sour varieties for 2 weeks at 32° F. with relative humidity of 80 to 85 percent. Color changes and decay can be retarded by use of carbon dioxide gas in storage or in shipment.

TABLE IV

CHARACTERISTICS OF LEADING CHERRY VARIETIES

Variety	Type	Maturity	Size	Color	Remarks
Bing	Sweet	Early to midseason (June 15 to July 1)	Large to very large	Dark red to purplish black	Red flesh, meaty, excellent flavor, dessert
Black Tartarian	Sweet	Early (June 10 to 20)	Medium	Purplish black	Red flesh, juicy, excellent flavor, dessert
Lambert	Sweet	Midseason to late (July 20 to August)	Large	Red brown to red black	Dark red flesh, meaty, good, flavor, dessert
Royal Anne	Sweet	Early to midseason	Large	Yellow with red blush	White flesh with yellow tinge, easily bruised. Good flavor. Popular canning variety
Schmidt	Sweet	Early	Large	Deep red to purplish black	Fleshy, juicy, good flavor
Montmorency	Sour	Midseason (July 15 to 25)	Medium	Light red to dark red	Flesh yellow to amber, juicy and acid
Early Richmond	Sour	Very early	Small	Light red to dark red	Flesh pale yellow, juicy, good flavor
English Morello	Sour	Midseason to late	Medium	Dark red	Good flavor, juicy

f. Procurement and inspection.—(1) Fresh cherries procured for Army use must meet the minimum requirements specified in Federal Specification Y-C-306. The cherries must be of U. S. No. 1 grade as described in the United States Standards for Grades of Fresh Cherries.

(2) There is little preference as to variety in fresh sweet cherries for dessert. When possible, procurement should be confined to the fruit with stems attached, since these will keep better and are more desirable for dessert purposes. Cherries should be inspected thoroughly for wormy fruit. Several cherries in each container should be cut, because worm damage is not always apparent on the outside. Soft, overripe, or shriveled fruit should be rejected.

SECTION IV

BERRY FRUITS

10. CLASSES.—Berry fruits may be classified as bush berries, such as raspberries, blueberries, blackberries, gooseberries, and currants; and low-plant berries, such as strawberries and cranberries.

11. BUSH BERRIES.—*a. Raspberries.*—Raspberries grown commercially in the Northwest and the Great Lakes regions are classified according to their color as red, black, and purple. The red raspberry is most popular because of its color, flavor, and superior shipping qualities.

(1) *Varieties.*—The leading red raspberry varieties and their characteristics are listed in table V.

TABLE V

CHARACTERISTICS OF LEADING RASPBERRY VARIETIES

Variety	Size	Maturity	Remarks
Latham	Large	Late	Hardy, firm, attractive
Cuthbert	Medium	Late	Excellent flavor, popular for canning
Chief	Small	Early	Excellent flavor, hardy
Ranere	Medium	Early	Firm, bright red, good flavor
June	Medium	Early	Bright red, good flavor
Hebert	Large	Midseason	Excellent flavor, very fragile
Newburgh	Very large	Late	Firm, good flavor, good for shipping

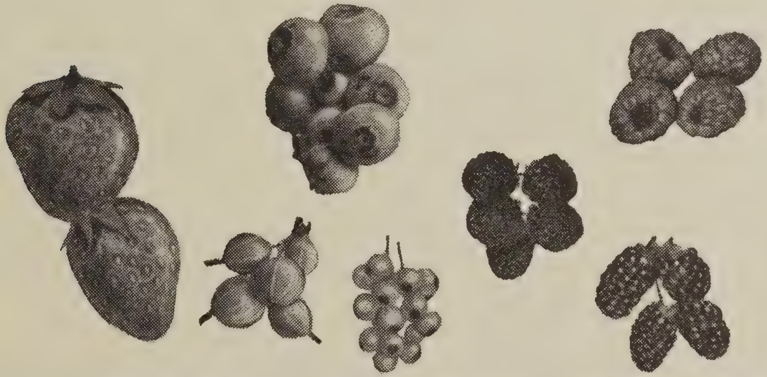


Figure 7.—Common berries: left to right, strawberries, gooseberries, blueberries, currants, black raspberries, blackberries, red raspberries.

(2) *Packaging.*—The market season for raspberries extends from early June to late August. Berries are usually marketed in crates holding 16,

24, and 32 pints or the same numbers of quarts. The 24-pint or the 24-quart size of crate is the most popular. Red raspberries should preferably be marketed in pint baskets because the fruit is so weak structurally, that if quart baskets are used, the weight of the top layers will crush the fruit.

(3) *Storage.*—Raspberries are very perishable and cannot be stored for more than 7 to 10 days, even under optimum conditions of 32° F. with 80 to 85 percent relative humidity. Prolonged storage results in the loss of the delicate berry flavor and in tissue breakdown.

(4) *Procurement and inspection.*—In general, red raspberries are too expensive for frequent use in army messes. All raspberries for army use must meet the minimum requirements as specified in Federal Specification Y-R-101. The fruit should be U. S. No. 1 grade as described in the United States Standards for Grades of Fresh Raspberries.

b. Blueberries.—Blueberries are described as large, dark blue, with a light green bloom on the surface. They contain numerous seeds that are so small as to be scarcely noticeable in eating. Huckleberries belong to the same family but differ in size, color, and number and size of the seeds. Huckleberries are small, bluish-black, and contain 10 large seeds with bony coverings which crackle between the teeth in eating. In New England there is a definite distinction between the two types, blueberries being more popular. In the Southern and Midwestern States no distinction is made between the berries.

(1) *Marketing and storage.*—Blueberries are marketed from early June to early September. The popular early varieties are Cabot and June; the midseason varieties are Concord, Pioneer, and Stanley; and the late varieties are the Jersey and Rubel. Blueberry varieties, free from huckleberries, may be mixed without lowering the market acceptance or quality. From the market standpoint blueberries should be sweet, have a pronounced flavor, be large-sized, blue in color, and free from a withered or wrinkled appearance. Blueberries are usually marketed in cases holding 16 or 32 quart baskets. Under optimum storage conditions of 30° to 32° F., blueberries may be stored from 7 to 10 days.

(2) *Procurement and inspection.*—Blueberries procured for Army use must meet the minimum requirements of Federal Specification Y-B-496. The berries should be carefully inspected, and should be free from worms, molds, dirt, excessive amounts of crushed berries, and huckleberries.

c. Blackberries.—Blackberries grow wild to some extent throughout the United States. Cultivation of blackberry varieties has produced fruit superior in size and quality. The most popular varieties are the Eldorado and the Snyder in the Northeast, Early Harvest in the South, Evergreen in the Northwest, and the Lawton and the Himalaya in California.

(1) *Marketing and storage.*—Blackberries are harvested from July through September, depending on variety. At maturity, berries should be of full size, fairly firm, sweet, and fully colored. Blackberries are very perishable and require great care in handling to prevent excessive bruising. Berries may be stored for several days at a temperature of 31° or 32° F.

(2) *Procurement and inspection.*—Blackberries procured for Army use must meet the minimum requirements specified in Federal Specification Y-B-426 for Fresh Blackberries, and must be U. S. No. 1 grade.

d. Miscellaneous berries.—Youngberries, loganberries, and boysenberries resemble blackberries in fruit structure.

(1) *Youngberries.*—The youngberry, an early maturing variety of the blackberry, is grown on a vine that runs along the ground. The Lucretia variety is the most popular, and ripens in June.

(2) *Loganberries.*—The loganberry has the size and shape of the blackberry, the color and soft structure of the red raspberry, and the flavor of both. The fruit, which is harvested from May to July, is popularly used in pies and for jams and preserves.

(3) *Boysenberries.*—The boysenberry is the result of crossing the loganberry, blackberry, and dewberry. The fruit is jet black and contains very few seeds. The boysenberry, the largest of all berries, often reaches 2 inches in length and 1 inch in diameter. It has excellent flavor and quality for dessert, canning, pies, jams, and juice.

(4) *Gooseberries and currants.*—Gooseberries and currants are grown commercially in the Northeastern States and are used principally for jams, jellies, and preserves. Generally, these fresh fruits are not used in army messes.

12. LOW-PLANT BERRIES.—*a. Strawberries.*—The production of cultivated strawberries is widespread, with the commercial producing areas centered in the South, Pacific Coast, and Great Lakes regions.

(1) *Varieties.*—At the present time there are over five hundred varieties, of which the following are the most popular:

Blakemore
Klondike
Marshall
Aroma
Howard 17
Missionary
Dorsett
Dunlap
Catskill
Fairfax

The berries of these varieties are large, bright crimson, have excellent flavor and appearance, and are used extensively for dessert, canning, and freezing.

(2) *Maturity and packaging.*—Strawberries ripen and are marketed between April and July. Mature berries should be fully red in color, plump,

firm, and free from dirt and insects. They should be picked with their stems attached. They are marketed in boxes (quarts or pints) or in trays. In the East the box is more popular, and 24 or 32 boxes are usually packed in a shipping crate. In the West the berries are placed on flat trays not more than 1½ inches deep, and 24 of the trays are put into a chest. The trays slip into guides so that they are held firmly in position without danger of pressure on the fruit. This method of packing is very satisfactory for distant shipping.

(3) *Storage.*—Because strawberries are very perishable, they should not be held for prolonged periods after purchase. Moisture, strong drafts, and sunlight cause rapid spoilage once berries are picked. Ten days is the maximum storage period even when berries are in the ideal stage of ripeness and when storage conditions are optimum, or 32° F. with 80 to 85 percent relative humidity.

(4) *Procurement and inspection.*—*(a)* All fresh strawberries purchased for Army use must meet the minimum requirements of Federal Specification Y-S-726 for Fresh Strawberries. The specification limits purchases to U. S. No. 1 grade as described in United States Standards for Grades of Fresh Strawberries.

(b) In the inspection of the fruit, particular attention should be paid to the stage of ripeness of the berries. Overripe berries are dull in appearance, mushy, and likely to be wet or leaky. Crushed or bruised berries decay rapidly and may be covered with mold. Berries that are covered with dirt or berries that have a foreign flavor should not be accepted.

b. Cranberries.—Cranberries are so high in acid that they are not palatable when eaten raw and are therefore used principally in making jelly and sauce.

(1) *Varieties.*—Cranberries are grown extensively in Massachusetts, New York, New Jersey, Wisconsin, Oregon, and Washington. Table VI lists the most popularly grown varieties.

TABLE VI

CHARACTERISTICS OF LEADING CRANBERRY VARIETIES

Variety	Locality	Size	Color	Season
Early Black	East	Medium	Dark crimson	Early
Hawes	East	Medium	Dark crimson	Late
Bennett	Wisconsin	Large	Light red	Late
Centennial	New Jersey	Large	Light red	Midseason
McFarlin	Wisconsin, Oregon, Washington	Large	Red	Midseason
Searles	Wisconsin	Large	Dark red	Midseason

(2) *Maturity.*—Cranberries ripen from early September to early November, depending on the variety. As the berries develop, they change in color from green to greenish white, then pink, and finally red. Some varieties become so dark that they are almost black, and others are light red with dark red spots or stripes on their surface.

(3) *Packaging.*—Cranberries are usually marketed in crates of 25 or 50 pounds. The crates are popular in most sections because bruising of the berries in shipment is reduced.

(4) *Storage.*—Berries are often harvested in the greenish-white stage and allowed to color in storage. The color developed in storage is not as deep as that which the berries have when they ripen on the vines. Cranberries of deep color endure temperatures of 23° F. without injury, while an immature, green berry will be injured at 28° F. Under optimum storage conditions, 36° to 40° F. and relative humidity of 85 to 90 percent, berries may be held from 1 to 4 months. Freezing injury resulting from excessively cold temperatures can be recognized by a rubbery consistency and the pink color of the flesh.

(5) *Procurement and inspection.*—Cranberries procured for Army use must meet the minimum requirements of Federal Specification Y-C-651 for Fresh Cranberries. They should be carefully inspected for frostbitten, soft, wet, shriveled, or wormy conditions.

SECTION V

GRAPES

13. GRAPES.—Grapes produced in the United States are chiefly of three types: The European (Western), the American (Eastern), and the Muscadine. The European type is grown almost exclusively in California and used for raisins and wine. The American type is grown in regions bordering the Great Lakes. Concord is the principal variety. The Muscadine type is grown in the Atlantic Coast States, along the Gulf Coast of Texas, and in States along the Mississippi River. Scuppernong is the principal variety.

a. Varieties.—The most important varieties of grapes are described in table VII.

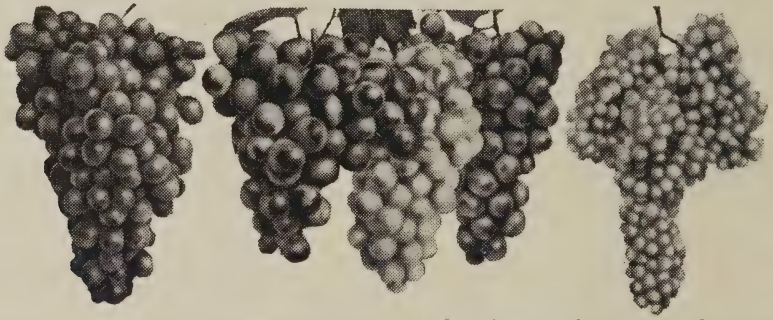


Figure 8.—Common grape varieties: left to right, Flame Tokay, Concord, Niagara, Emperor, Thompson Seedless.

b. Packaging.—Containers used for shipping Eastern grapes are:

(1) *Climax baskets* of 2-, 4-, and 12-quart sizes, with dimensions prescribed by the National Package Law. These wood veneeer baskets, usually marketed in the 12-quart size, are commonly used for marketing table grapes. Because the bottom of the basket is narrower than the top, the fruit at the bottom may occasionally be defective.

(2) *Lug boxes,* which hold 25 to 35 pounds of fruit, are also used for marketing table and juice grapes.

(3) *California lugs and crates,* used for shipping grapes grown in California, have been standardized by the laws of that state as follows:

Container	*Capacity (pounds)*
Standard Lug No. 1	32
Standard Lug No. 2	27
Standard Lug No. 3	24.5
Standard grape crate (holding 4 chip baskets)	24 (approx.)

TABLE VII

CHARACTERISTICS OF LEADING GRAPE VARIETIES

Type	Variety	Maturity	Size	Color	General Remarks
European or Western	Alexandria	Midseason	Large	Yellow green	Important raisin variety. Excellent quality, juicy, and highly flavored
	Tokay	Midseason	Large	Red	Quality fair, not juicy, good flavor
	Malaga	Midseason	Large	Bright to dark red	Excellent dessert grape, good shipping and storage qualities
	Emperor	Late	Large	Dark cherry red	Good variety for storage and shipping
	Thompson Seedless	Early	Medium	Yellow green	Seedless variety, excellent flavor, most popular for dessert
	Red Muscat	Midseason	Large	Yellowish red	Very good quality, juicy, well flavored
American or Eastern	Concord	Midsummer late	Medium to large	Black	Very popular for grape juice, resistant to insects and disease, good quality
	Niagara	Midseason to late	Medium to large	Yellow green	Good all-purpose variety, good quality, juicy, and high flavor
	Delaware	Early to midseason	Small to medium	Light red	Popular variety, fine quality
	Catawba	Late	Medium	Purple red	Excellent all-purpose variety
	Moore	Midseason	Medium to large	Purple black	Good quality, thin tender skin
	Worden	Early to midseason	Large	Purple black	Good quality, juicy, tendency to crack badly
Muscadine	Scuppernong	Midseason	Medium	Green to red brown	Variety very popular, juicy, sweet and excellent quality

(4) *Jumble packs,* a method of packing grapes loosely in containers, should never be used for long shipments of grapes.

c. Storage.—(1) Grapes of the Western varieties may be satisfactorily stored from 4 to 6 months at 31° to 32° F. with 85 to 90 percent relative humidity. Fumigation with sulfur dioxide before storage or the use of sodium bisulfite in a pad at the bottom of the lug is desirable as a means of keeping down decay.

(2) Eastern varieties are not adapted to long storage but may be held from 3 to 4 weeks at 31° to 32° F. with 80 to 85 percent relative humidity. Low humidity causes shriveling.

d. Procurement and inspection.—(1) Grapes purchased for the Army should meet the minimum requirements of Federal Specification Y-G-671. The grade requirement of the specification that grapes procured "shall be U. S. No. 1 Table Grapes" may cause some confusion. In some instances, a decision as to whether a given lot of grapes is composed of table grapes or of juice grapes is based upon quality only; in other instances, the question is decided by the variety of the grapes, for some grape varieties are used for juice only. Therefore, prior to procurement of grapes, it is well to ascertain what varieties of table grapes are available on local markets.

(2) From the variety of containers used, it is evident that grapes should be purchased by the pound. The tare should be determined by emptying and weighing a suitable number of containers.

(3) Grapes should be carefully inspected for the presence of bruises, diseases, rot, decay, insects, and any foreign substances.

CITRUS FRUITS

14. PRODUCING AREAS.—Citrus fruits are among the earliest fruits eaten by man. Oranges, grapefruit, lemons, and limes, constituting the major citrus fruits, are largely produced in Florida, California, Arizona, and Texas.

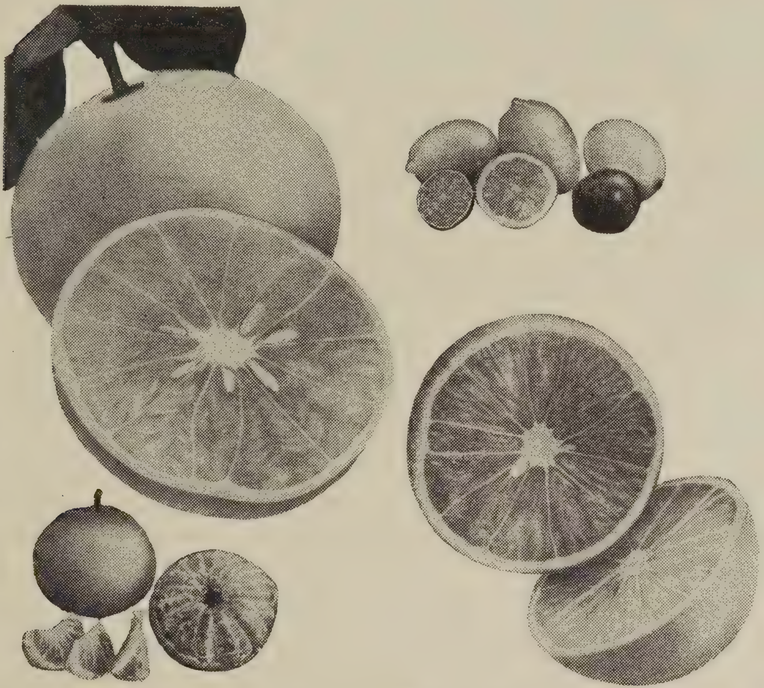


Figure 9.—Left to right: top, Duncan grapefruit, lemons, limes; bottom, tangerines and Valencia orange.

15. ORANGES.—*a. Classification and varieties.*—The more than two hundred varieties of oranges grown in the United States may be grouped in three general classes, sweet, tangerine, and Seville or sour.

(1) *Sweet orange varieties.—(a)* The sweet orange is the most important of all the citrus fruits. In Florida the bulk of the sweet orange crop is produced between October and June. The varieties are classified as early, midseason, and late. The most common early varieties are the Hamlin and Parson Brown; the midseason varieties are the Pineapple and Homosassa; and the late variety is the Valencia. These varieties are described in table VIII.

(b) In California one early variety, the Washington Navel, and one midseason variety, the Valencia, have proved sufficient to produce an orange crop every month in the year.

(c) In Texas the Hamlin is the most desirable early to midseason variety. Other varieties grown in Texas are the Valencia, Pineapple, Parson Brown, and Texas Navel.

(2) *Tangerine varieties.*—Tangerine fruit differs from the sweet orange in that it is smaller, the rind is easily separated from the pulp or flesh, and the sections of the pulp are readily separated from one another. The only variety extensively produced in Florida is the Dancy. In Texas the Clementine and the Warnuco varieties are superior to the Dancy in flavor and quality. In California the Dancy is of inferior grade, having high acidity and small-sized fruit. The season of the Dancy is from December to March, and that of the Clementine is from November to January.

(3) *Seville or sour varieties.*—The Seville or sour orange has a limited production because of its extreme acidity. It is used mainly in making marmalades.

b. Maturity.—Oranges often reach legal maturity before they develop their normal coloring. Citrus fruits or any variety growing on heavily foliaged trees and in dense shade retain much of their greenness even after full maturity. Valencia oranges develop almost full orange color in winter, but do not mature until spring. After new growth starts in the spring, these oranges "regreen," particularly at the stem end. Therefore, if allowed to remain on the tree until full ripe, the regreened oranges have the appearance of being immature.

c. Degreening.—Since oranges generally command a price commensurate with their appearance, it is highly desirable to make their color and appearance a criterion of their eating quality. With legally mature fruit this may be achieved by the process of degreening, generally known as "coloring." The latter term is somewhat misleading, for no color is added to that which has already been developed naturally. However, in certain other processes sometimes used, artificial colors are added. In such cases each fruit must be labeled accordingly; but if dyes conceal damage or inferiority, the color declaration in the label will not bring the product in conformity with the Food and Drugs Act. In reality, degreening, or coloring as here described, is merely a stimulation of natural processes by which the green pigment (chlorophyll) is made to disappear and any shades of orange present in the rind are brought out. The treatment neither produces nor changes the orange color; neither does it in any sense ripen the fruit. In California, the treatment is usually referred to as "sweating."

TABLE VIII

CHARACTERISTICS OF LEADING SWEET ORANGE VARIETIES

Variety	Locality	Maturity	Size and shape	Color	Rind	Seeds	Flavor	Market season
Hamlin	Florida	Early	Medium to small, oval	Yellow orange	Smooth and glossy	None	Excellent	Oct to Nov.
Parson Brown	Florida	Early	Medium, oblong	Yellow to yellow-orange	Smooth, ⅛ to $\frac{3}{16}$ inch thick	10 to 19	Good	Oct to Nov.
Washington Navel	California	Early	Large, round	Orange to orange-yellow	Smooth, ⅛ to ¼ inch thick. Large oil cells.	None	Excellent, rich, sweet, juicy	Nov. to May
Pineapple	Florida	Midseason	Medium to large	Deep orange reddish tinge	Glossy smooth, about ⅛ inch thick	Large and numerous	Vinous, sprightly, pineapple aroma	Dec. to Feb.
Homosassa	Florida	Midseason	Medium to large, round	Deep orange	Smooth and glossy	20 to 24	Excellent, rich, vinous	Dec. to Feb.
Valencia	Florida,, California	Late	Large, Slightly oval	Pale orange to yellow-orange	Smooth or slight pebbled, thin but not tough	2 to 5	Excellent	Mar. to June (Florida) ; May to Nov. (California)

(1) *The process.—(a)* In modern commercial practice, oranges are degreened in one of several types of so-called "coloring" rooms. All are so operated that the fruit is held in warm air of high relative humidity, into which small quantities of some gaseous reagent are introduced. The reagent is usually either ethylene or the pungent fumes resulting from the incomplete combustion of kerosene. This conditioned air is circulated through the stacks of fruit by means of fans or blowers. Ethylene is the more commonly used degreening agent, because it is almost odorless when diluted, is much cleaner, and does not impart an unpleasant flavor to the fruit as kerosene fumes sometimes do.

(b) The concentration of ethylene used is often as much as 1 part in 5,000 parts of air. While the minimum effective concentration has not been accurately determined, it is known that 1 part in 50,000 parts of air continuously maintained is as good as the intermittent application of heavier dosages, as commonly practiced under some methods of treatment. In the so-called trickle method of continuous application now generally used in Florida, 1 to 2 cubic feet of ethylene per carload per day is sufficient. The temperature is raised by means of live steam and radiators; steam jets may also be used to provide humidity in cold weather. A fine spray of cold water is sometimes used in hot weather to provide humidity and to lower the air temperature. For best results the temperature should generally be held between 80° and 85° F., with a relative humidity from 90 to 92 percent. The powerful fan in the air-conditioning chamber circulates the air around the stacked fruit, withdraws it from the coloring room through the slatted floor, carries it through the air-conditioned chamber, and recirculates it. Provision is also made for the continuous introduction of necessary fresh air and the removal of the products of respiration.

(2) *Stacking.*—The fruit, in field boxes, is stacked 5 or 6 feet high, depending on the weight of the boxes and the height of the ceiling in the coloring rooms. The common practice in Florida is to stack four standard field boxes or five two-thirds-standard boxes. A distance of at least 2 feet should be left between the top box and the ceiling to allow good air circulation and to insure more nearly uniform temperature in all parts of the stacked fruit.

(3) *Time required.*—The time required for degreening is dependent to a great extent on the variety and quality of the fruit, the coloring-room equipment, and the weather. In general, green, or nearly green, oranges at the beginning of the season require from 48 to 60 hours to "color." Oranges picked later in the season may not require more than 36 hours for degreening, but Valencias always take longer. Grapefruit requires

about 12 hours less than oranges. After the fruit has been degreened, it should be packed and chilled as soon as possible.

(4) *Supervision.*—Sucessful degreening requires alert and intelligent supervision. In the large houses, one man who thoroughly understands the process has complete charge of the coloring rooms because the degreening treatment is the most delicate and involved part of the entire packing-house procedure.

(5) *Causes of failure.*—Some of the common causes of failure or difficulty in degreening are:

(a) If the top fruit colors at a rate different from that at the bottom, heating facilities are inadequate or the air circulation is insufficient to maintain a uniform temperature throughout the room.

(b) Slow coloring in cool or cold weather indicates insufficient heating facilities; in warm weather it indicates insufficient ventilation.

(c) Noticeable wilting during the coloring process indicates too low humidity or excessive temperature, or excessive air circulation if humidity is moderately high. The greater the rate of air circulation, the higher the humidity must be held in order to prevent wilting.

(d) Excessive decay after degreening may be caused by insufficient ventilation and air circulation, by too much humidity if the fruit has not been previously treated with an antiseptic, or by the use of too much gas.

d. Grading, packing, and marketing.—(1) *Seasons.*—Oranges are harvested in the United States throughout the year. In California the season begins with Navel varieties, which mature from November to May, and extends through the harvest of the Valencia varieties, which mature from May through November. In Florida the orange varieties mature from October through June.

(2) *Appearance.*—Commercially, citrus fruits are graded for color and appearance, as Fancy, Choice, Standard, or Culls. Discoloration, scarring, texture of skin, and freedom from disease and parasitic growth are the chief points taken into consideration.

(3) *Trade names.*—The California and Florida orange crops are marketed chiefly through cooperative marketing associations. In recent years, these associations have tended to market oranges under trade names which designate grade. For example, in California, "Sunkist" indicates the highest grade fruit, and "Red Ball" second grade. In Florida "Sealdsweet" indicates top-grade fruit, and "Morjuice" the second grade.

(4) *Sizes.*—Oranges are graded and packed according to sizes, which are designated by the number of fruit that can be packed in a standard box. The California standard box measures 11½ by 11½ by 24 inches and holds approximately 60 pounds of oranges. Florida and Texas use a box which

measures 12 by 12 by 24 inches, and which holds a slightly greater amount of fruit. The California, Florida, and Texas standard boxes contain approximately 1-3/5 bushels. A 2-bushel box, known as the "Bruce box," is also used in Florida markets. The Bruce box differs from the standard box in that it is constructed of heavier material, is usually strapped with wire, and has no center partition. The most satisfactory container for army purchases is the standard box. The sizes used and the corresponding diameters are shown in table IX.

TABLE IX

STANDARD BOX CONTAINERS FOR ORANGES

Size (oranges)	Minimum diameter (inches)	Maximum diameter (inches)
96	3-6/16	3-11/16
126	3-3/16	3-8/16
150	3	3-4/16
176	2-14/16	3-2/16
200	2-12/16	3
216	2-10/16	2-14/16
250	2-8/16	2-12/16
288	2-6/16	2-10/16
324	2-4/16	2-8/16

e. Storage.—Oranges do not store well for periods longer than 1 or 2 months. The best storage temperature is 32° to 34° F. with a relative humidity of 85 to 90 percent. If stored too long, oranges become pitted or develop large, brown, slightly sunken spots at the stem end. Fruit in storage should be inspected frequently, and decayed or diseased fruit should be removed at once.

f. Procurement and inspection.—Oranges for Army use must conform to Federal Specifications Y-O-660 or Y-O-662 and must meet the minimum requirements of this specification for the U. S. No. 1 grade. The most desirable sizes for Army use are those included in the range between 150 and 216 oranges per box. All oranges should be carefully inspected with respect to maturity, firmness, decay, and also bruises caused by external injury. Some oranges from each shipment should be cut and tested for flavor.

16. GRAPEFRUIT.—Because grapefruit are susceptible to damage by cold, they are most successfully produced in southern Florida, California, Arizona, and Texas. The best grapefruit are smooth, fine-skinned, and feel "heavy." Large necks usually denote thick skin.

a. Varieties.—Many varieties of grapefruit are produced. They vary in size, color of skin, color of flesh, number of seeds, and the degree of acidity and sweetness. The Marsh variety constitutes practically the entire crop in California and Arizona.

b. Degreening and grading.—The processes used in degreening oranges are applied to grapefruit. Grapefruit are graded mechanically with respect to size and the number which may be packed in a standard box, as indicated in the following table:

TABLE X

STANDARD BOX CONTAINERS FOR GRAPEFRUIT

Size (grapefruit)	Minimum diameter (inches)	Maximum diameter (inches)
36	5	5-9/16
46	4-11/16	5-2/16
54	4-6/16	4-3/16
64	4-3/16	4-9/16
70	3-15/16	4-5/16
80	3-12/16	4-2/16
96	3-9/16	3-15/16
126	3-5/16	3-11/16

c. Storage.—Storage rooms for grapefruit should have a relative humidity of 85 to 90 percent. Lower humidities cause pitting, and higher ones may increase decay. For short-time storage, grapefruit can be held satisfactorily at a temperature of 32° F. For longer periods, the temperature to be used depends on the character of the fruit and the diseases most likely to be encountered. In sections where stem-end rot is prevalent, the storage temperature should be about 32° to 34° F. A temperature of 45° to 55° F. is desirable in sections where stem-end rot does not exist, but where storage pitting and watery breakdown develop if the fruit is stored at temperatures of 40° F. or lower. Sound fruit that is not overmature can usually be held for 6 weeks without serious spoilage.

d. Procurement and inspection.—Grapefruit purchased for Army use must conform to the minimum requirements of Federal Specifications Y-6-680 or Y-6-682. Purchase is limited to U. S. No. 1 grade. Grapefruit packed 64 to 70 per box are the most satisfactory size for Army use. The fruit should be inspected for rot, bruises, and disease. Various samples should be sliced and tested for flavor.

17. LEMONS.—California produces approximately 99 percent of the domestic lemon crop. Some attempts have been made to grow lemons in Florida, but the soil and climate tend to produce fruit too large in size and too coarse in texture to meet market requirements. The industry is

TABLE XI

CHARACTERISTICS OF LEADING GRAPEFRUIT VARIETIES

Variety	Locality	Season	Size	Color	Rind	Flesh	Flavor
Marsh	Florida Arizona California	Midseason February March	Medium 3½ inches	Light	⅛ inch thick	Gray-green, 13 sections no seeds	Medium acidity and sweetness. Bitterness not marked.
Hall	Florida	Midseason February March	Large 4½ inches	Light yellow	$\frac{3}{16}$ inch thick	14 sections 32 seeds very juicy	Bitter factor present. Acidity and sweetness strong.
Walters	Florida	November to March	Medium 3¾ inches	Pale yellow	¼ inch thick	13 sections 58 seeds	Bitter factor strong. Acidity and sweetness strong.
Duncan	California Texas Florida Arizona	January to June	Medium to small 3½ inches or less	Light yellow	$\frac{1}{16}$ inch thick	Light gray-green 14 sections 5 seeds	Marked bitterness. Acidity and sweetness medium.
Triumph	Florida	December and January	Small 3½ inches or less	Light yellow	⅛ inch thick	11 sections 37 seeds juicy	Bitterness not marked.

based upon two varieties, Eureka and Lisbon, which meet the requirements of consumer demand.

a. Varieties.—The Eureka and Lisbon varieties vary in their periods of heaviest production. The Eureka matures in late spring and summer, and the Lisbon matures in winter and spring. In marketing, because no attempt is made to separate the two varieties, both are handled as domestic fruit.

b. Maturity.—Lemons are degreened by the same processes as those described for oranges and grapefruit. They are harvested when they reach a marketable size, not when they have attained full-yellow color. This is necessary because fruit left to ripen on the tree becomes coarse, fibrous, and deficient in juice flavor.

c. Packaging.—Lemons are packed in standard lemon boxes measuring 10 by 13 by 25 inches, and divided in half by a partition. The number of lemons packed varies from 180 to 558 per box, depending on fruit size.

d. Storage.—Lemons may be stored satisfactorily for 3 months when held at 55° F. with relative humidity of 85 to 90 percent. At lower temperatures the fruit is likely to develop red blotches, membranous stains, and rind pitting.

e. Procurement and inspection.—Lemons procured for the Army must meet the minimum requirements of Federal Specification Y-L-231. The fruit packed 360 per box are the most satisfactory size for army use. Lemons should be carefully inspected for rot, disease, and conformance with specifications for good quality fruit.

18. LIMES.—Florida produces practically all the domestic lime crop. The fruits are variable in size and shape and are known commercially as "Mexican" or "Key" limes. Limes are marketed in greatest quantities during the summer months.

19. DISEASES AND DEFECTS OF CITRUS FRUITS.—Citrus fruits are subject to various rots which develop after harvest. The kind of rot depends on the climatic conditions of the locality where the fruit is grown and on the handling and storage methods employed. The development of the organisms that cause decay is influenced greatly by the temperature and humidity after harvest, as well as by the stage of maturity of the fruit.

a. Penicillium rots are the most widespread form of decay and are known as green-mold rot, blue-mold rot, blister rot, and pinhead rot. They occur during the cooler months or when fruit has been held in cool or cold storage for some time. Temperatures between 50° and 70° F. are most favorable to their development. Infection occurs for the most part as a result of such mechanical injuries as bruises, cuts, and breaks in the skin. Susceptibility increases with advancing maturity. Control rot is maintained by careful handling at all stages to prevent mechanical injury to the fruit, and by storing the fruit at a temperature below the optimum for growth of the decay organisms.

b. Stem-end rot is a serious problem in Florida where the climate is humid. This rot is characterized by a softening and decay of the rind and pulp tissue in the stem area. Usually, all stem-end rot infection occurs while the fruit is on the tree and remains inactive in the stem or stem parts until the fruit is harvested. When the atmosphere is humid and warm, the rot develops rapidly and causes heavy deterioration within 10 days to 2 weeks after harvest, but it can be controlled by careful handling and by refrigerated storage.

c. Brown rot is sometimes serious in California. Prolonged warm, rainy periods favor the outbreak of this disease, the presence of which can be detected by a characteristic odor.

d. Blossom-end rot is a common disease among oranges but is rarely serious. Early in the season before the fruit has lost its green color, infected fruits have a pinkish discoloration around the blossom end. Later, when the fruit matures, this discoloration disappears. The affected area enlarges very slowly, and very little of the flesh decays except in extreme cases. Navel oranges seem to be most subject to this disease.

e. Russeting is a discoloration or blemish on citrus fruits which mars their appearance. Grapefruit and Florida and Texas oranges are often overcast by a reddish-brown color known as russeting. This does not affect the flavor of the fruit. In many markets such fruit is cheaper in price. California oranges are not subject to russeting.

f. Freezing injury often occurs in citrus fruits which have been subjected to low temperatures in storage or during transit. The first sign of freezing is the appearance of spotted areas on the rind of the fruit. One of the earliest internal indications of frost damage in citrus fruits is the formation of small white crystals in the pulp or membrane. These white crystals appear within 5 to 10 days after the freezing and can best be seen by cutting the fruit transversely and tearing the segments apart. Orange flesh freezes at 28.0° F. and orange rind at 27.4° F. Oranges that have been frozen sometimes develop a bitter taste and have a flat and insipid flavor. Citrus fruit which has been frozen may be made palatable and wholesome if properly handled. The fruit should be thawed slowly in cool storage so that it will not dry out rapidly and so that fermentation will be retarded.

SECTION VII

MELONS

20. MUSKMELONS.—Muskmelons, usually referred to as cantaloups, honeydews, and honeyballs, are extensively grown in California, Colorado, Arizona, Utah, New Mexico, North Carolina, Texas, Nevada, and Delaware. California, Arizona, and Colorado produce approximately 75 percent of the commercially grown cantaloups.

a. Varieties.—Regardless of varieties, muskmelons are generally classified in accordance with the color of the edible portion, namely, salmon meat, pink meat, and green meat. Brief descriptions of some of the more popular varieties of each type follow:

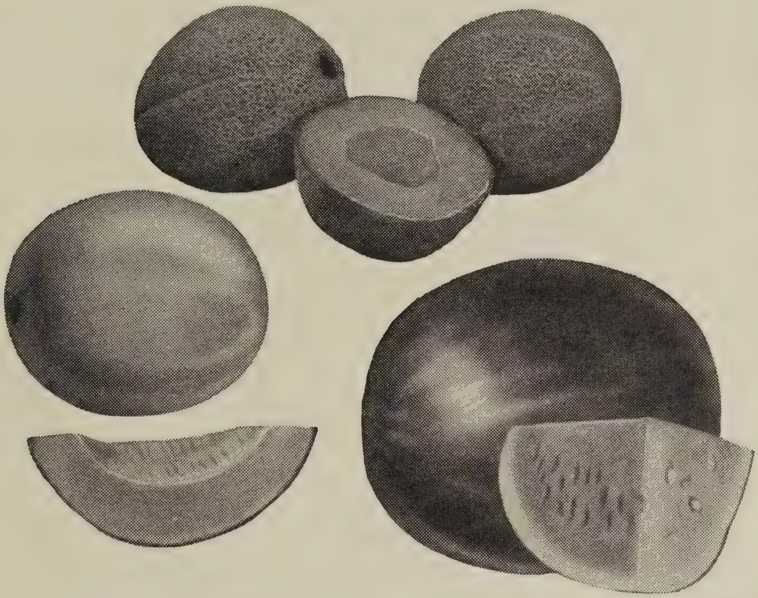


Figure 10.—Left to right: Honeydew melon, cantaloups (top), watermelon.

(1) *Salmon meat.*—The flesh is usually greenish near the rind, and salmon-colored toward the center. The shape of the melon is usually round, and the netting completely covers the rind. Immature melons of this group have flesh that is almost green. The most popular varieties produced are Pollock 10-25 and Abbott Pearl.

(a) The Pollock 10-25 is of medium size, has little or no ribbing, and is heavily netted. The flesh is a deep salmon color, shading to a deep green near the rind, juicy, and highly flavored.

(b) The Abbott Pearl is medium to large, whitish-green, without ribs, and is completely covered with coarse netting. The flesh is a deep salmon color from the center to the rind. It has a good flavor and is an excellent shipper.

(2) *Pink meat.*—The flesh is orange or pink throughout. The leading varieties are Burrell Gem, Tip Top, and Hearts of Gold.

(a) The Burrell Gem is of medium size and oval. The ribs are heavily netted and well defined by clearly marked sutures. The flesh has a rich pink color and spicy flavor. It is a good shipper.

(b) The Tip Top is medium to large, weighs 5 to 8 pounds and is slightly oval. Its well-defined ribs are covered with light netting. The flesh has a pink to deep-yellow color. It is a poor shipper.

(c) The Hearts of Gold is of medium size, slightly ribbed with sutures, and covered with light netting. Its flesh has a rich orange color and excellent flavor. It is a good shipper. One of the characteristics of this variety is that the melons do not yellow in ripening, but retain their natural green color.

(3) *Green meat.*—The flesh is usually green from the center to the rind. The melon is round, and the netting varies from coarse to very fine. The most popular varieties are Netted Gem, Honeyball, and Honeydew.

(a) The Netted Gem is an Eastern variety, medium in size, and weighs from 2 to 3 pounds. It is slightly oblong, ribbed, and covered with a fine netting. The green flesh is juicy and has a good aroma and flavor.

(b) The Hackensack is a large melon, prominently ribbed and coarsely netted. The flesh is green in color, juicy, and sweet.

(c) The Honeyball is slightly netted, greenish-white to light yellow. The green flesh is sweet and of good flavor. The melon is firm and ships well.

(d) The Honeydew is large in size, about 6 inches in diameter, and weighs from 5 to 6 pounds. The rind is smooth and greenish-white to creamy-yellow. The flesh is green, sweet, and juicy. It is a good shipper.

(e) The Golden Beauty (Casaba) is large, 7 to 10 inches in diameter, and weighs from 6 to 10 pounds. The rind is greenish-white, furrowed (not ribbed), with no netting. The flesh is light green, juicy, sweet, and good in flavor. This melon is marketed from midsummer to late fall.

(f) Santa Claus (Persian) is large, 6 to 8 inches in diameter, and weighs from 8 to 12 pounds. The rind is green and very sparsely netted. The flesh is white or light yellowish-green, sweet, and juicy.

b. Maturity and quality.—(1) Most muskmelons ripen during the months of May to October, depending on the locality. Certain varieties, known as winter melons, are marketed in the late fall and early winter (except Santa Claus).

(2) Sweetness and flavor in muskmelons are not fully developed until the melons have ripened on the vines. Ripeness in almost all melons is indicated by the softening of the part of the fruit which surrounds the "eye" or "button" at the blossom end. If ripe, this part of the melon yields to finger pressure. However, too much reliance should not be placed on this test because softening can be induced by repeated pressure. The odor of most melons becomes stronger as the full stage of ripeness is reached. In some melons a change of color from green to a yellowish or cream shade is an indication of ripeness.

(3) The stage of maturity in cantaloups is also indicated by the netting on the rind surface. The netting should be coarse or grayish in color and well developed. Cantaloups picked at "half slip" (that is, before they are fully ripe) usually have part of the stem still attached. A fully ripe cantaloup, "full slip," separates cleanly from the stem when picked, leaving a smooth, sunken, well-calloused stem scar. Overmature cantaloups are usually soft, watery, and insipid. This condition is generally indicated by a very pronounced yellowing of the rind showing through the netting. Immature cantaloups have a flesh that is hard, tough, and flavorless.

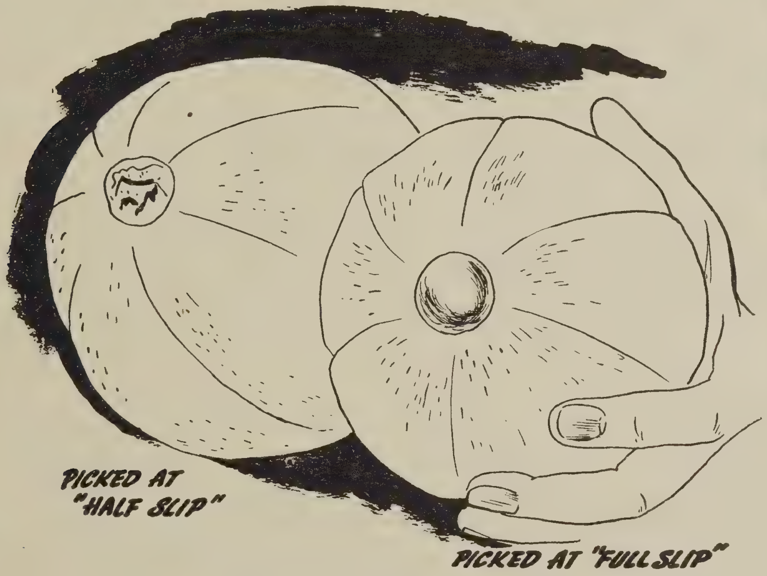


Figure 11.—Melon ripeness test.

(4) Honeydew or Honeyball melons are generally considered matured when the color of the skin has changed from a dark-green to a light

yellow-green or cream shade, and when there is a slight softening at the blossom end. The flesh of ripe melons is very tender, juicy, sweet, and flavorful, and has a strong aroma.

c. Packaging.—(1) Melons are marketed in crates of different names and sizes. Crates used in the Eastern and Central States are known by the same names as those used in the West, but there is considerable variation in the construction and dimension of the eastern crates. These variations are due to the fact that eastern growers always attempt to pack the same amount of melons to the crate. Thus, since the melons may vary in size, they have to make the crate fit the melons. The western crates used in shipping melons are as follows:

TABLE XII

WESTERN CRATES FOR MELONS

Type of melon	Name of crate	Inside dimensions (approx. inches)	Number of melons per crate
Cantaloup and Honeyball	Standard Jumbo Standard Flat Jumbo Flat	12 x 12 x 22½ 13 x 13 x 22½ 4½ x 13½ x 22½ 5 x 14½ x 22½	36 or 45 27, 36, or 45 9, 11, 12 or 15 6, 9, 12, or 15
Honeydew	Standard Jumbo	6¾ x 16 x 22½ 7¾ x 16 x 22½	8, 9, 11, 12 or 15 6, 8, or 9
Golden Beauty (Casaba)	Standard	8¾ x 16 x 22½	5 to 8
Santa Claus (Persian)	Standard Jumbo Special Jumbo	7¾ x 14 x 22½ 9¾ x 16 x 22½ 11¾ x 18 x 22⅛	5 to 8 4 to 6 3 to 4

(2) Crates are usually labeled to show the brand, size of the crate, and number of melons packed; for example, Standard 45, Jumbo 36. Shipments of freight loads of standard crates from the West usually contain about 336 crates; from the East they will average about 448. A car loaded with flat crates will range from 576 to 968 crates, depending on the number of layers stacked.

d. Storage.—Melons can be held for only 7 to 10 days at temperatures of 32° to 34° F. Honeydew melons that are held at cold-storage temperatures develop a type of low-temperature breakdown after 7 to 10 days. The first symptom of this breakdown is usually a faint water soaking of the rind accompanied by an oozing out of the melon juice so that the rind becomes moist and sticky. Cantaloups that have been held in cold storage and then removed rapidly develop small black spots on the rind. This is the first indication of a rot known as Cladosporium rot, which develops most readily at the stem scar and in bruised areas. Melons of prime quality and maturity are readily susceptible to rot and low-temperature breakdown if held in storage for a prolonged period. Optimum storage temperature is 38° to 42° F., with a relative humidity of 75 to 85 percent.

e. Inspection.—Melons should be inspected for maturity, firmness, cracks, sunburn, decay, and moldiness. The laws of some states require that melons meet certain minimum maturity tests, such as the test for soluble solids content in the juice of the edible portions of the melon. Cantaloups having growth cracks are undesirable unless they are eaten immediately after picking, because the cracks provide an entrance for organisms which cause decay and souring of the flesh. Decay in melons usually is in the form of dark, sunken, water-soaked patches that may or may not be covered with mold. The flesh of a melon affected by decay is not harmed provided the decay has not penetrated the rind. Periodic examination should be made of stored melons so that any melons which begin to show injurious effects of storage may be removed.

21. WATERMELONS.—Watermelons are most widely grown in the Southern States, with Georgia producing the greatest percentage of the commercial crop.

a. Maturity.—Watermelons are considered mature and of good quality when they are symmetrical in shape, firm, fresh, and of a good color varying from deep, solid green to grayish green, the color depending upon the variety. A common test for proper maturity of watermelons is the sound given off when the melon is thumped. It is assumed that the melon is ripe when the thump produces a dull, hollow sound. This test is not absolute because a mature melon may be dead ripe or stale, in which case the flesh is dry, mealy, and insipid. Immature watermelons usually have a hard, greenish, unripe appearance, and the underside is usually white or pale green. Overmature melons have a dull, lifeless appearance, and feel soft or springy when finger pressure is applied. In general, sweetness, fine texture, and flavor of the flesh are the factors which determine quality in melons.

b. Defects.—Worm injury is sometimes found in watermelons. The external indications are healed-over punctures; however, when the melon is cut, burrows or grooves will be found extending from the punctures. Decay in watermelons appears as flattened, dry, leathery spots. Sometimes the melon may have a white streak running lengthwise through the flesh. This condition is known as white heart.

SECTION VIII

TROPICAL FRUITS

22. AVOCADOS.—The avocado, also known as the "alligator pear," is a native of Central and South America. Its production in the United States is limited to California and Florida. The fruit for the most part has a dark green skin and varies in shape, being oval, pear-shaped, or round. It contains a single central seed, and its flesh has a bright greenish-yellow color. The avocado is distinguished from other fruits by its oil content, which ranges from less than 8 percent to as high as 20 percent. Also it is practically immune to worm infestation. Although the avocado is classified as a fruit, its principal use is as a vegetable in salads. Avocados are abundant during the winter and spring months, when other salad fruits and vegetables are costly and not plentiful on the market. The principal avocado markets are located in the Pacific Coast, Central, and Gulf States.

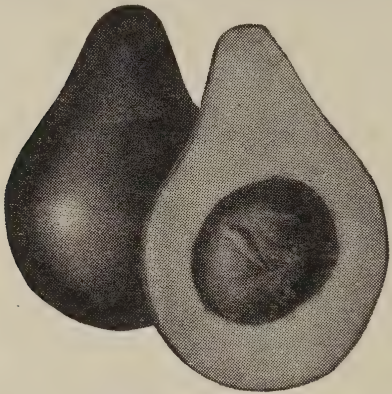


Figure 12.—Avocado.

a. *Varieties.*—California produces about one hundred different varieties of avocados, of which the Fuerte and the Nabal are the most popular. The Fuerte variety represents about 80 percent of the California crop. Avocado varieties may be divided into two groups:

(1) Fruit which for the most part is green (although some are dark-skinned), pear-shaped, and thin-skinned, and which ripens from November to July.

(2) Fruit which varies in size, shape, and color, and which ripens from May to October. Summer varieties are generally much larger in size. They may be perfectly round, or pear-shaped, or have long necks, and they may range in color from a light yellowish-green to maroon or even purple.

b. *Maturity.*—(1) Although avocados are allowed to mature or ripen on the tree, they are still firm when harvested. They are best when the fleshy portion is the consistency of butter at a temperature of 55° F. The fruit is classified according to three maturity stages: firm, breaking, and ready-to-eat. Fruit can generally be brought from the firm to the breaking stage by exposure to a normal room temperature for 4 or 5 days. Breaking fruit can be brought to the ready-to-eat stage by 24 to 48 hours' exposure to normal room temperature.

(2) Avocados should always be tested for maturity or ripeness by palm pressure, because the thumb test produces discoloration of the flesh of the fruit and is really no indication of its ripeness or softness unless it has passed the breaking stage. Maturity or ripeness of avocados is truly determined by picking representative samples from each lot and testing them for oil content before harvesting the crop. The California State law prohibits the sale of avocados with less than an 8 percent oil content.

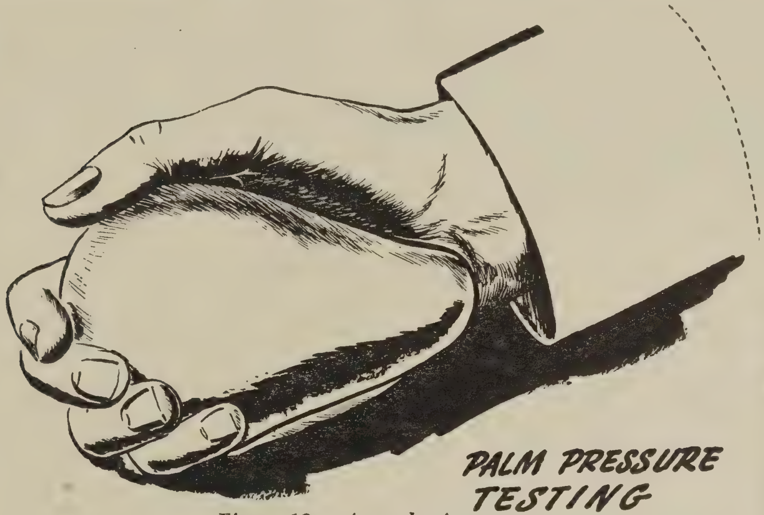


Figure 13.—Avocado ripeness test.

c. Packaging.—Avocados are easily bruised and require careful handling. In preparation for shipment, the fruit should be packed in excelsior or shredded paper. Commercial-size fruit is packed in flats of 13 pounds net weight.

TABLE XIII

PACKING AVOCADOS

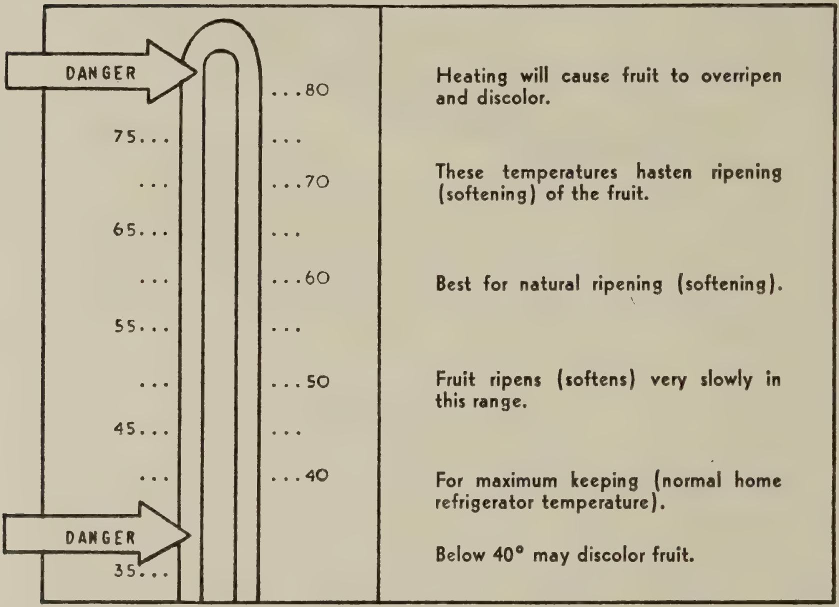
Number of fruit per flat	Weight of individual fruit (ounces)	Net weight per flat (pounds)
35	5 to 6½	13
30	6½ to 8	13
24	8 to 10	13
20	10 to 12	13
16	12 to 14½	13
14	14½ to 16½	13
12	16½ to 19½	13
10	19½ to 23	13
9	23 to 25	13
8	25 to 29	13

d. Storage.—(1) To insure soundness and good keeping quality, avocados should be stored at a temperature of 40° to 50° F. Softening of the fruit may be hastened by storing in a temperature of 70° to 80° F. but in no instance should the fruit be placed over or under direct heat. Until ready for use, the fruit should always be left in the flats in which it is received. The flats should be stacked so that air circulates well between them.

(2) Fruit at the ready-to-eat stage which has been received at a temperature of 80° F. or above should be consumed at once; or it can be refrigerated at 40° F. and held not more than 48 hours. Table XIV indicates the best temperature ranges at which avocados should be kept and at which they ripen naturally.

TABLE XIV

AVOCADO RIPENING



Heating will cause fruit to overripen and discolor.

These temperatures hasten ripening (softening) of the fruit.

Best for natural ripening (softening).

Fruit ripens (softens) very slowly in this range.

For maximum keeping (normal home refrigerator temperature).

Below 40° may discolor fruit.

e. Procurement and inspection.—The procuring officer should use discretion in purchasing fruit so that it will be ready to eat when he wishes to use it. Often the flesh of the fruit acquires black areas as a result of bruises and mishandling. This does not indicate that the fruit should be discarded, because the discolored portion can be cut away and the remaining fruit used.

f. Preparation and use.—(1) Avocados are used chiefly in salads, either fruit or vegetable, but may also be combined with sea food and meats. They are best prepared by first cutting them in half, either crosswise or lengthwise, removing the seed, and then peeling the skin from the fruit, much as a banana is peeled. The skin will be removed easily if the fruit is at the ready-to-eat stage. The cut fruit, if to be held more than a few hours, should be sprinkled with lemon juice or vinegar to prevent surface darkening.

(2) Avocados should always be peeled and the flesh eaten in its raw or natural state. They should never be cooked or subjected to high temperature. Avocados that have reached the very soft stage may be used as a base for salad dressing or, in combination with other flavorful ingredients, as a spread for bread or crackers.

23. BANANAS.—The banana is the most prolific of all fruits and is grown in nearly all tropical regions. The principal variety grown in the American Tropics is the Gros Michel.

a. Trade terms.—(1) A commercial terminology peculiar to the banana trade has developed. Each banana plant or tree, developed to maturity, bears a single bunch of bananas which is made up of "hands" (clusters), each containing from 10 to 20 individual bananas or "fingers." Commercially, bunches of bananas are classified as ranging from 6 to 9 hands of not less than 10 fingers each. "Nines" are bunches containing 9 fully developed hands. Bunches having less than 6 hands are not readily marketable.

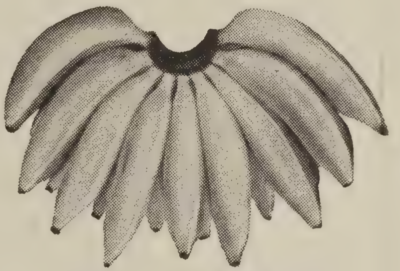


Figure 14.—Hand of bananas.

(2) "Stems" is a general term applied to bananas irrespective of class, and has exactly the same meaning as bunches.

(3) "Grade" refers distinctly to the fullness of the fruit when harvested.

(4) A bunch varies in weight according to the soil and climatic conditions under which it is grown. The average weight of a 9-hand bunch ranges from 60 to 80 pounds.

b. Maturity.—The banana is one of the few fruits which attain maximum flavor and food value when harvested green and allowed to ripen off the tree or plant. The ripening consists of progressive physical and chemical changes. Starting from a hard, green, and starchy condition, the fruit gradually becomes softer in texture, turns from green to yellow, and becomes more and more sweet to the taste as the starch originally present is converted to sugar. The speed of ripening is controlled by temperature, relative humidity, and ventilation. The ripening process cannot extend for less than 3 days or more than 10 days without affecting the quality of the fruit. Within these limits, bananas are ripened under three sets of temperature conditions:

(1) *Fast ripening,* 3 to 4 days at 70° F., 90 percent relative humidity, with no ventilation until fruit is well colored.

(2) *Medium-speed ripening,* 5 to 7 days at 64° F., with 90 percent relative humidity, and no ventilation until fruit is well colored.

(3) *Slow ripening,* 8 to 10 days at 62° F., 90 percent relative humidity, with ventilation at a rate of three to four air changes per hour.

Properly ripened fruit should have a good, attractive color, fresh appearance, a firm plump texture, and good strength of peel. Flavor should be unimpaired by the ripening treatment.

c. Degrees of ripeness.—Three well-recognized degrees of ripeness in bananas are outlined in Federal Specification Y-B-91, covering the purchase of bananas. These are "full ripe," "hard ripe," and "turning ripe." The corresponding commercial terms are "fully ripe," "yellow ripe," and "partially ripe."

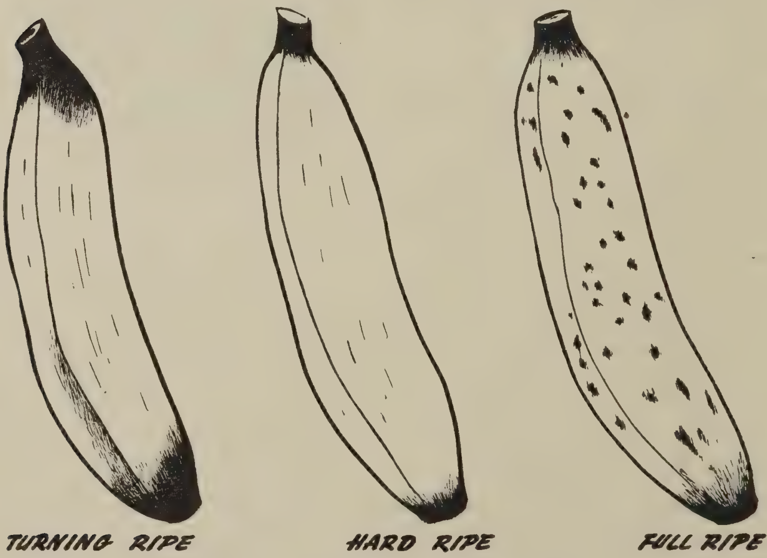


Figure 15.—Degrees of banana ripeness.

(1) *Full ripe or fully ripe.*—The skin contains no trace of green, but is typical, ripe-banana color, well flecked with light-brown to dark-brown specks varying in size from pinpoints of brown to spots one-eighth inch in diameter. Bananas in this stage must be consumed within 24 hours.

(2) *Hard ripe or yellow ripe.*—The entire skin is a bright banana color with no trace of brown specks. The texture is firm, and the flavor has a decided astringency. Bananas at this stage may be safely held for 3 days.

(3) *Turning ripe or partially ripe.*—The skin is a pale banana color, with the tip entirely green. The banana has little flavor, is sharply astringent, and, because of starch and tannins present, should not be eaten uncooked. At this stage bananas may be held safely for 5 or 6 days.

d. Storage.—The optimum holding temperature for ripe bananas is from 60° to 68° F., with optimum relative humidity from 75 to 85 percent, and ventilation of three air changes per hour. Under these conditions bananas may be held 7 to 10 days. Storage below 56° F. results in a "chilling" of the fruit, affects fruit flavor, and causes skin discoloration.

e. Packaging.—When bananas are marketed, they are sold unboxed, or are packed in wooded (returnable) boxes or cartons. For army purposes, the cartons have definite advantages over wooden boxes: Their light weight facilitates delivery; they present a cleaner and more attractive appearance; and they eliminate the necessity of storing empty boxes. Cartons must be kept dry, and should be of good corrugated or solid fiberboard. Cheap board may develop a sag at the bottom and may collapse from the weight when stacked. Wooden boxes are preferable for shipping bananas any great distance, because they reduce bruising and other shipping damages and because they give protection against chilling. The best way to unpack bananas is to stand the box on end with the inverted hand of bananas at the bottom. This causes the bands to slide far enough down in the box so that the top can be lifted out by the collar. Do not lift by holding the bananas themselves.

f. Procurement and inspection.—(1) Bananas procured for Army use must meet the minimum requirements of Federal Specification Y-B-91. Fruit that is to be consumed within 24 hours should be purchased full ripe; that which is to be held for 3 days should be in the hard ripe stage; and that which is to be held from 5 to 7 days should be in the turning ripe stage.

(2) Every lot should be carefully inspected for size and fullness of fingers and for degree of maturity. Fruit which shows considerable bruised areas because of rough handling should not be accepted. Fruit which is riper than that specified should not be accepted unless it can be used at once.

24. PINEAPPLES.—Pineapples are grown extensively in the Hawaiian and Philippine Islands. In the United States, Florida leads in the commercial production of pineapples. The Red Spanish variety constitutes the major portion of the total crop.

a. Maturity and marketing.—(1) Color and odor indicate quality and maturity in the fruit. A ripe pineapple has a clean, fresh appearance, and has a distinctively dark orange-yellow color and a fragrant aroma. Immature fruit is small, purplish-green in color, and has partially developed "eyes." Fruit at this stage is of poor flavor and, if stored, will not ripen well. Fruit which is plant-ripened possesses a very fine quality and flavor, but is too mature for shipment, being subject to bruising and mechanical defects. The best stage of maturity is known as the "hard ripe" or "yellow ripe" stage, when the fruit is a reddish-yellow color and still firm.

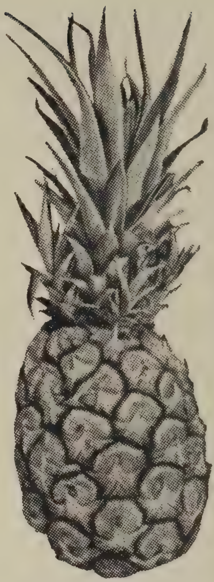


Figure 16.—Well-formed pineapple.

(2) Although some pineapples ripen and are shipped at all seasons of the year, the main harvest season for Florida extends from late May to mid-July. For marketing, the fruit is picked about a week before maturity. It is graded as to size —18, 24, 30, 36, 42, 48, 52, according to the number that can be packed in crates measuring 12 by 10 by 36 inches.

(3) Pineapples may be satisfactorily stored from 2 to 4 weeks at temperatures not over 50° F. Disease and rot develop rapidly at temperatures of 70° to 90° F.

b. Diseases.—Because pineapples are very susceptible to disease, they must be handled carefully to keep bruising and subsequent decay at a minimum. Some of the common diseases and defects are soft rot, heart rot, sunburn, and molding.

(1) *Soft rot.*—This disease of the fruit results in a soft, dark, fermented, and decayed condition. It develops from careless, rough handling, and is controlled by proper packing and storage at temperatures of 40° to 45° F. for ripe fruit and at 50° to 60° F. for green fruit.

(2) *Heart rot.*—This disease, which first manifests itself as a water-soaked condition in the portion around the heart or center of the fruit, progresses outward until the entire fruit is involved. It is usually accompanied by rotting, and the fruit becomes bitter and inedible.

(3) *Sunburn.*—Pineapples are sometimes affected by sunburn, which causes the flesh beneath the affected area to be hard, pithy, and dry.

(4) *Mold.*—Mold growth may develop as a result of bruising, improper storage, and improper packing. It is found at the base or around the eyes of the fruit.

c. Procurement and inspection.—Pineapples for Army use should be procured in accordance with the conditions outlined in Federal Specification Y-P-381. Pineapples must be of U. S. No. 1 grade only, and must be graded according to the United States Standards for Grades of Fresh Pineapples. In size, they should be 18, 24, or 30, as specified in the invitation for bids. Prior to acceptance, pineapples should be carefully inspected for maturity, presence of disease, or mechanical defects.

SECTION IX

STORAGE OF FRESH FRUITS (SUMMARY)

25. TEMPERATURES.—Proper temperatures and storage conditions are most important in the storing of fresh fruit. The optimum conditions of storage vary. Experience has proved that low temperatures are necessary, for they tend to retard both the deterioration resulting from the natural respiration process of the fruit and the decay caused by fungi and bacteria. However, storage at low temperatures will not correct damage done by spoilage or mechanical injury incurred prior to storage. For most fruits, a temperature close to 32° F. is optimum, with a preferred relative humidity of about 85 percent. (Higher temperature can often be used satisfactory for short storage.) Table XV summarizes the storage conditions suitable for the various fruits.

26. AIR CIRCULATION.—One of the first considerations for successful storage of fresh fruit is proper air circulation, *i. e.,* circulation that is not obstructed. Whatever types of storage containers are used, they should be so stacked as to permit air circulation. The containers should never be directly on the floor of the storage room. Strips of wood, known as dunnage, should be laid on the floor so that the first layer of cases is about 2 or 3 inches above the floor. Additional dunnage should be used to separate every 2 or 3 feet of layers. In this way, horizontal air circulation is obtained. Vertical circulation is provided by stacking the cases several inches from all walls, with an occasional aisle to permit ease in checking fruit. Packed boxes should always be stacked on the side, never on the top which is bulged. Do not stack boxes on the ends because it concentrates the weight on a smaller area, increasing the chance of bruising the fruit.

27. CAUTIONS.—*a.* Since fresh fruits continue to respire in storage, they should not be stored in the same room with potatoes, onions, and

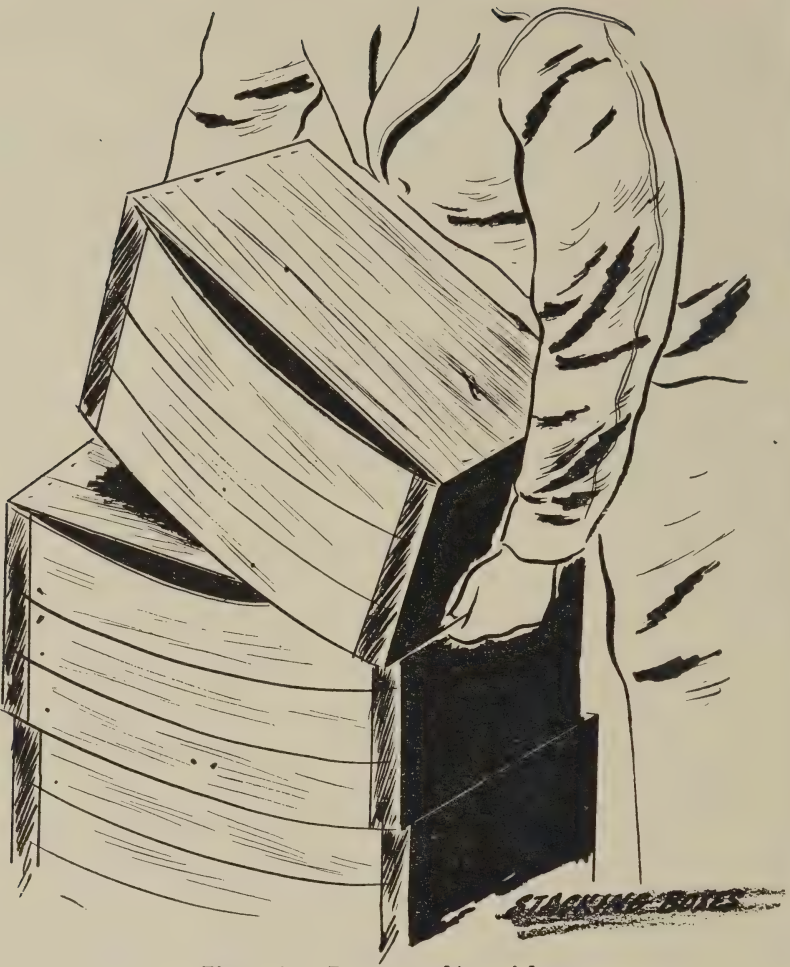


Figure 17.—Proper stacking of boxes.

other odoriferous vegetables, from which they will absorb undesirable odors. Because citrus fruits emit odors, they should not be stored in the same room with dairy products.

b. In general, raspberries, blackberries, dewberries, loganberries, and strawberries are not adapted to long storage. A week or 10 days is probably the maximum storage period for all, even at 32° F. As an aid in preventing decay, careful handling is important at all stages of the marketing process.

c. All fresh fruits in storage should be inspected periodically to remove any which have begun to spoil or deteriorate.

TABLE XV

STORAGE PROPERTIES OF FRUITS

Fruit	Storage temperature (degrees F.)	Relative humidity (percent)	Storage life (approximate)	Average freezing point (degrees F.)
Apples	31 to 32	85 to 88	4 to 6 months	28.4
Avocados	40 to 50	85 to 90	3 to 4 weeks	27.2
Bananas	60 to 68	75 to 85	7 to 10 days	26.0
Blackberries	31 to 32	80 to 85	7 to 10 days	28.9
Cherries	31 to 32	80 to 85	10 to 14 days	28.0
Cranberries	36 to 40	85 to 90	1 to 4 months	27.3
Dates	30 to 32	75 to 80	3 to 6 months	–4.1
Grapefruit	32 to 34	85 to 90	6 to 8 weeks	28.4
Grapes				
European Type	31 to 32	85 to 90	4 to 6 months	24.9
American Type	31 to 32	80 to 85	3 to 4 weeks	27.5
Lemons	55 to 58	85 to 90	1 to 4 months	28.1
Limes	45 to 48	85 to 90	6 to 8 weeks	29.3
Melons				
Muskmelon	32 to 34	75 to 76	7 to 10 days	28.5
Honeydew and Honeyball	36 to 38	75 to 85	2 to 4 weeks	28.8
Casaba and Persian	36 to 40	75 to 85	4 to 6 weeks	....
Watermelon	36 to 40	75 to 85	2 to 3 weeks	28.8
Oranges	32 to 34	85 to 90	1 to 2 months	28.0
Peaches	31 to 32	80 to 85	2 to 4 weeks	29.4
Pears,				
Bartlett	30 to 31	85 to 90	45 to 90 days	....
Pineapples	30 to 45	80 to 85	2 to 4 weeks	29.9
Plums	31 to 32	80 to 85	7 to 10 days	28.0
Raspberries	31 to 32	80 to 85	7 to 10 days	30.4
Strawberries	31 to 32	80 to 85	7 to 10 days	29.0

CHAPTER TWO

DRIED FRUITS

SECTION I

INTRODUCTION

28. IMPORTANCE TO THE ARMY.—*a.* The primary importance of dried and dehydrated fruits in time of war is their conservation of shipping and storage space. One ton of dried or dehydrated fruit is roughly equivalent in food value to about five tons of fresh or seven tons of canned fruit. Comparisons of weight and space requirements for the more important fruits are shown in table I.

b. Dried and dehydrated fruits are harvested at a higher degree of maturity than canned or fresh fruits, with a resultant higher proportion of nutrient value. In the modern improved methods of preparation practically all of these nutritious constituents can be preserved.

TABLE I

COMPARATIVE WEIGHTS AND VOLUMES OF FRUIT PACKED FOR SHIPMENT — BASIS: ONE TON FRESH FRUIT

Fruit	Fresh Fruit Commercial wood boxes		Canned Fruit Cases of No.2½ cans		Dried Fruit 25 lb. bulk pack boxes	
	Weight lbs.	Volume Cu. Ft.	Weight lbs.	Volume cu. ft.	Weight Lbs.	Volume cu. ft.
Apples	2240	61.5	2460	49.0	232	6.9
Apricots	2380	51.5	3300	65.5	408	9.0
Peaches, freestone	2310	56.0	2400	48.0	373	8.3
Pears	2240	46.0	2400	48.0	373	9.5
Prunes	2420	45.0	....	....	800	15.9
Raisins, seedless	2320	45.0	3300	50.0	530	14.1

29. SCOPE.—*a.* This manual is limited to those fruits which have a high proportion of natural fruit sugars, and which, after packaging, generally have from 16 to 25 percent moisture and from 50 to 70 percent sugar. Incidental mention is made of other dehydrated fruits such as berries, although the dehydration and handling of these fruits correspond more nearly to methods used for vegetables. Only incidental mention is made also of fruits which are not available in large quantities.

b. In table II are given the actual tonnages of the various California dried fruits for the period 1932 through 1941. The average annual production is seen to be slightly over one billion pounds.

TABLE II

PRODUCTION OF CALIFORNIA DRIED FRUITS

	1932 Crop (tons)	1933 Crop (tons)	1934 Crop (tons)	1935 Crop (tons)	1936 Crop (tons)	1937 Crop (tons)	1938 Crop (tons)	1939 Crop (tons)	1940 Crop (tons)	1941 Crop (tons)	10-Yr. Av. Crop
Apples	9,710	13,263	8,200	11,887	11,322	11,543	7,456	10,532	4,759	8,530	9,720
Apricots	35,171	37,331	16,983	25,540	32,228	34,269	21,385	40,957	11,349	19,709	27,492
Figs	13,426	18,366	21,415	23,327	17,594	27,643	30,013	26,653	31,192	33,000	24,263
Peaches (Free)	21,731	22,066	20,446	15,706	19,135	18,084	18,333	19,975	18,807	13,378	18,766
Peaches (Cling)	323	1,278	5,339	3,821	7,079	4,793	3,613	3,894	5,610	1,459	3,721
Pears	5,456	6,967	4,720	6,075	8,111	3,486	6,431	8,066	3,083	3,608	5,600
Prunes	165,212	179,873	175,173	262,704	158,674	248,338	223,560	185,057	164,365	175,987	193,894
Total raisins	262,286	180,833	158,432	198,550	183,591	248,276	292,163	247,162	170,022	206,383	214,770
Thompsons	—	135,717	107,000	147,715	135,268	188,405	216,285	178,249	148,671	175,770	159,231
Sultanas	—	6,953	5,000	5,828	4,760	6,130	7,130	5,200	2,257	2,393	5,072
Muscats	—	23,446	26,000	23,582	24,543	27,769	32,835	25,322	7,180	12,106	22,531
Bleached raisins	—	11,476	16,942	19,376	16,845	23,436	31,826	33,676	7,819	15,119	19,613
Other raisins (including dried grapes)	—	3,241	3,490	2,049	2,175	2,536	4,087	4,715	4,095	995	3,042
Kernels	3,255	3,285	1,750	2,988	3,260	3,949	1,797	4,302	1,608	2,201	2,840
Nectarines	—	—	328	368	349	297	337	371	117	217	238
Silver prunes	112	152	128	123	64	110	203	95	—	—	99
Total of above	516,682	463,414	412,914	551,089	441,407	600,788	605,291	547,064	410,912	464,472	501,403

(These figures represent the total receipts of dried fruits by members of the California Dried Fruit Association plus estimates where data enable proper estimates. They probably do not vary more than 2% from the total California production.)

30. GEOGRAPHY OF THE INDUSTRY.—Dried and dehydrated fruits are produced in many parts of the world. The principal producers outside the United States are Australia, the Union of South Africa, France, and the Mediterranean countries. Within the United States dehydrated apples are produced in practically every apple-growing district. The principal producing areas are California, the Pacific Northwest (Washington, Oregon, and Idaho), and New York, with additional commercial quantities produced in Virginia, Illinois, Arkansas, and Missouri. Dehydrated prunes are produced in the Pacific Northwest as well as in California. With these two exceptions, the entire dried and dehydrated fruit industry may be considered to be in California alone.

31. RELATION TO OTHER FRUIT INDUSTRIES.—*a.* A condition of varying equilibrium exists between California's dried, canned, and fresh fruit industries in that each year the entire harvest is apportioned to these industries in varying amounts. When fruit is scarce competition becomes quite active. In the case of raisins (grapes) the canned fruit industry drops out of the picture and the wine industry enters in. Competition for the farmer's grapes has brought an increased prosperity to the entire fruit industry. Since all fruits are in competition for the farmer's land, the fruit which brings the highest return is planted in preference to others. The increase in grape prices has tended to increase the prices for all other fruits by reducing their plantings and availability.

b. Table III gives the approximate acreage (California) of fruits that are dried, together with the average yield per acre, and the length of the drying season.

TABLE III

APPROXIMATE ACREAGE, YIELD PER ACRE, AND DRYING SEASON FOR FRUITS DRIED IN CALIFORNIA

Fruit	Approximate planting (acres)	Approximate annual yield per acre (dried tons)	Drying season
Apples	35,000	1.8	Sept. 1—Dec. 1
Apricots	33,000	1.0	June 15—Aug. 1
Figs	34,000	1.5	July 1—Oct. 15
Nectarines	....	1.5	July 15—Aug. 30
Peaches (Cling)	42,000	1.0	Aug. 1—Sept. 15
Peaches (Free)	39,000	2.0	July 15—Sept. 15
Pears	44,000	1.5	July 15—Oct. 1
Prunes	137,000	2.0	Aug. 15—Oct. 1
Raisins (Sundried) Muscat	59,000	1.0	Aug. 15—Nov. 1
Raisins (Sundried) Seedless	172,000	1.5	Aug. 1—Nov. 1
Raisins, Bleached	....	....	Aug. 1—Nov. 1
Raisins, Zante Currants	3,000	1.5	Aug. 5—Aug. 20

c. The first concern of the grower is the fresh fruit market, as the best prices are obtained for the fresh fruit. This market cannot begin to accept the entire harvest, and as the season progresses and prices decline fruits go to other channels. The canning industry each year demands a certain minimum quantity of each fruit. This is the second preference of the grower, although again this market cannot accept the entire year's production. The dried and dehydrated fruit industry serves as a cushion to absorb the balance of the crop, and also to utilize enormous tonnages that are produced solely for drying. The dried fruit industry thus is both a primary industry in that fruits are grown specifically for the purpose of drying, and is also a by-product industry in that drying utilizes fruit that cannot be absorbed by the fresh, canned, and fermented fruit industries.

d. Similarly, dehydration can be classed both as a primary industry and as a subsidiary to sun-drying. Some fruits and fruit products are dried either solely or principally by dehydration, and dehydration at times is resorted to when sun-drying is inadequate. Since as a general rule dehydration by artificial heat results in a superior product, significant increases are to be expected in the volume of dehydrated fruits. Raisins are probably the only fruit which will always be produced mainly by sun drying.

e. Pears are produced primarily for canning and fresh sale; the competition by dried fruit packers for a portion of the crop aids materially in maintaining prices paid to growers. About two-thirds of the apricot crop is dried, but the fresh and canned markets are very important to most growers. Some peaches are produced primarily for the fresh market, some exclusively for drying, and some primarily for canning. Some grapes likewise are grown primarily for the fresh market with balances going into wine; some are produced for wine-making only; and considerable quantities are grown for raisin production only; although some raisin varieties also are diverted to the fresh fruit and wine industries. Figs, with the exception of the Kadota, a canning variety, are almost exclusively a dried product; and evaporated apples are almost entirely a by-product of the fresh fruit market. Prunes are grown almost exclusively for drying, whereas other varieties of plums are grown for the fresh and canning industries, with virtually none being dried. Almost the entire cherry crop, as an example of most other fruits, is utilized by the fresh and canning (and other processing) industries. Very few cherries are dried or dehydrated.

f. Table IV shows the approximate distribution of California fruits among these industries. The figures given are approximate averages for the period 1934-1938.

TABLE IV

DISPOSITION OF CALIFORNIA FRUITS

Variety of fruit	Sold fresh (percent)	Dried or dehydrated (percent)	Canned (percent)	Otherwise processed, including wine (percent)
Apples, California	57.4	35.2	0.2	7.2
Apricots	8.3	66.5	25.2	....
Cherries	54.4	....	16.7	28.9
Grapes	13.5	41.3	0.2	45.0
Prunes, California	....	100.0	....	....
Plums	97.0	....	3.0	....
Pears	55.5	14.6	29.9	....
Peaches	16.0	28.9	55.1	....
Figs	6.3	87.9	5.8	....

SECTION II

PRODUCTION PROCEDURES

32. GENERAL.—This section describes each step in the production of dried and dehydrated fruits, from the harvesting of green fruit through the packaging of the final product. Each procedure is taken in turn, regardless of the fruits to which it applies. Section III takes each fruit in turn and lists the production procedures applicable to it.

33. HARVESTING.—*a. Cut fruits* (fruits which are cut before drying) should be picked from trees by hand when firm ripe. Immature fruit is low in sugars and other nutrients, dries to a poor consistency and an off-color, and deteriorates rapidly in subsequent storage; overripe fruit, although healthful and nutritious, will not retain the desirable contour and appearance of dried fruit, resulting in "slabs," a substandard product. The practice of shaking fruit from trees onto the ground or canvas sheets instead of picking by hand results in the harvesting of immature fruit, bruises the fruit, and causes dirt to be imbedded in the skin. About three pickings by hand per season are required for peaches and apricots. Apples, a relatively hardy fruit, do not require the care that peaches and apricots do, but they too should be protected against bruising and other damage.

b. Whole fruits.—(1) Grapes must be picked at full maturity to obtain the maximum sugar content, oversize bunches trimmed so the fruit will not lie too deep on the tray (maximum depth about 2½ inches), and any vineyard mold, smut, or rot trimmed from the bunches; all the fruit is harvested in one picking. Table V shows the relation between maturity of fresh grapes and the sugar content of raisins (dehydrated) produced from these grapes.

(2) Prunes, with a very tough skin, are always harvested from the ground, after shaking the trees to cause immature fruit which has not already fallen of its own accord to drop; two to three pickings are required.

(3) Figs dry to a very great extent upon the trees, and then drop to the ground of their own accord. This fruit should be harvested at least two or three times each week to prevent insect contamination while on the ground.

c. All fruit must be handled with sufficent care after harvesting to prevent bruising. Harvested fruit, with the exception of apples and pears, should be delivered to cutting or processing stations at once and always within twelve hours, to maintain freshness and vitality.

34. FRESH FRUIT STORAGE.—*a.* Pears are the only fruit in which storage prior to drying is an essential process. All pears, whether used

TABLE V

SUGAR CONTENT OF RAISINS IN RELATION TO MATURITY

Muscat of Alexandria		Thompson Seedless	
Balling degree of fresh grapes	Sugar content of soda-dip dehydrated raisins (percent)	Balling degree of fresh grapes	Sugar content of Golden Bleached raisins (percent)
17.1	63.2*	17.8	69.3*
18.6	63.7	19.6	71.4
19.7	65.5	21.0	70.4
21.4	66.7	22.0	70.9
23.3	68.1	23.1	71.1
25.1	68.1	24.2	72.0
27.4	67.5	24.7	71.9
		26.9	71.8
		28.0	71.8
		29.7	71.7

* 15 percent moisture in raisins.

fresh, canned, or dried, are picked green and allowed to ripen in storage This storage is generally at atmospheric conditions, although it can b delayed at reduced temperatures. The use of ethylene gas in the storag chambers effects a more rapid and uniform ripening. The fruit require up to ten days or more for ripening, and must be examined and sorte frequently to remove fruit at the proper maturity.

b. Apples frequently must be held in storage before drying. This storag is not beneficial but unless prolonged it has no particular adverse effect If the storage is to be for a long time it should be at reduced temperatures

c. All other fruits should be dried as soon after harvesting as possible Storage for 24 hours or even less is certain to cause a reduction in quality

35. WASHING.—*a.* All cut fruits, with the exception of lye-peele peaches, should be washed with water to remove all dirt, evidence of insec activity, and any other foreign matter immediately before cutting.

b. The washing of whole pears is extremely important as the growin fruit is treated with lead arsenate to control insects, and spray residue remain on the fruit. Federal Food and Drug regulations permit onl extremely small quantities of residual lead and arsenic, and complet removal is essential. Special washing machines have been devised whic include an acid dip for lead removal, caustic dip for arsenic removal, plu brushing and clear water washing. Their use is strongly recommended Pears also frequently are given an additional wash on trays after cuttin and trimming, before drying.

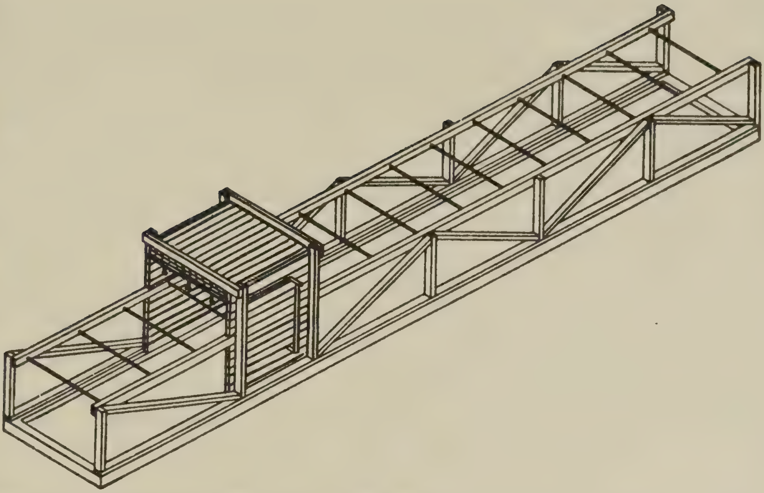


Figure 18.—Cut-pear washer. The loaded trays are placed on a roller conveyor and passed into a spray chamber where rows of spray heads, two from above and one from below, wash the fruit and bottom of the tray. The conveyor and catch basin are extended to permit the trays to drain.

c. Washing is not possible with sun-dried grapes which are picked directly onto trays in the vineyard. Dehydrated grapes are dipped for other purposes prior to dehydration, and must be washed with clear water after dipping to remove all traces of dirt and residue from the lye dip. Figs should be washed with clean water prior to drying to remove orchard dirt, especially if artificial heat is used in drying. All wash water must be clear and fresh and not recirculated. When necessary, as in the case of prunes, fruit should pass through a leaf and trash remover either before or during the washing operation.

36. PEELING.—Apples and clingstone peaches are the only fruits peeled before drying. Peaches are peeled, generally whole, in a hot lye solution and all evidence of the solution is removed by a vigorous subsequent washing, generally in an inclined rotating drum. Apples are peeled by mechanical or hand-operated machinery which peels and cores the fruit in one operation. Core particles, residual peel, and calyxes or stems affect quality, and these must be removed by hand if necessary. Extreme care must be taken to remove all stem and calyx particles as these often contain poisonous residues from spraying.

37. SIZE GRADING BEFORE DRYING.—Grading for size before drying is limited solely to dehydrated fruit. The smaller fruit dries more rapidly than the large, and since all fruit is to be dried to a uniform moisture

content, the sizes should be segregated. This also insures against overdrying and scorching. Grading for only two sizes is necessary. Grapes and figs do not require size grading before dehydration. In the case of apples, the very small fruit should be discarded as the returns for it often will not cover the costs of peeling and slicing.

38. DIPPING.—Some whole fruits are dipped in cold water, hot water, or weak caustic solution before drying. Sulfur-bleached raisins are generally dipped lightly in hot weak lye solution to "check" the skins (produce very light small cracks) to facilitate moisture removal in dehydration. Soda-bleached raisins, either muscat or seedless, are dipped in soda solutions of various composition to produce a light colored skin. Prunes which are to be sun dried are generally given a lye dip to check the skins. The lye dipping tends to cause excess bleeding during dehydration, however, and prunes which are to be dehydrated are generally dipped in cold, warm, or hot water rather than lye only long enough to remove the bloom from the fruit. Any fruit dipped in chemicals must be thoroughly washed with clear water to remove all trace of the chemical.

39. CUTTING AND PITTING.—*a.* This applies only to cut fruits. Peaches and apricots are cut into halves along the suture of the fruit. Sharp knives are essential to insure a smooth cut surface; the entire circumference must be cut to prevent the ragged edges which would result from tearing the fruit in two. Pits are removed in this operation and should be placed in a container other than the box containing the fruit to avoid contaminating the whole fruit. Halves are placed on drying trays, cut side up. Clingstone peaches are cut, generally after lye peeling, and the pit removed with a spoon shaped knife; this is generally done by machine rather than by hand. In removing pits from freestone peaches pieces of pit will often remain on the fruit. These pit particles constitute a very serious defect and must be removed entirely.

b. Pears have no suture and are cut in half lengthwise, generally by hand. Cores generally are not removed, although coring does result in a more attractive product. It is highly important that the entire calyx (and preferably also the stem) be removed, as residual arsenic, lead, and other spray residues are retained in these extremities in spite of the most thorough washings. Any trimming necessary to remove insect or other damage should be done at this time, and such fruit of lowered quality should be segregated. Trimmings in no case should be permitted to fall into the box containing whole fruit.

c. (1) Apples, after peeling, are cut into slices, quarters, or halves. Slicing done at the time of coring gives a higher proportion of perfect rings than when it is done later, but it complicates trimming and often results in incomplete removal of bits of core, seeds, and skin, thus reducing the quality of the product. Slicing or cutting is best done after the peeled and cored fruit has been trimmed. Special slicing machines with adjustable blades are used for cutting the apples. Thickness of the slices range from three-sixteenths to one-fourth inch. Occasionally slices three-eighths inch thick are prepared. The knife blades and metal parts of the slicer coming in contact with the fruit should be washed frequently in order to avoid unnecessary metallic contamination which may later cause discoloration. All slices are cut perpendicular to the core.

(2) Apples cut into quarters, sixths, and eighths have been prepared primarily for the export trade. They are obtained by forcing the cored, peeled, and trimmed apples through a die in which radial knives are set. This method of cutting gives pieces of uniform size. It also permits a heavier load per square foot on trays when trays are used for drying. A load of three or four pounds of quartered fruit per square foot is handled and sulfured as easily as two or three pounds of slices. In spite of the fact that the drying time is increased, the additional load may result in increased drying capacity for a given plant.

(3) Occasionally apples have been cubed. In this form they are readily sulfured and dried. The finished product has an attractive and uniform appearance and cooks readily. Some additional cost is involved in the cubing operations and in screening out of fine pieces resulting from handling.

(4) Table VI gives cost figures on the peeling and drying of apples of various sizes, and shows that the returns received for very small apples is actually less than the cost of production.

40. WASTE DISPOSAL.—In the preparation of cut fruits there is always a certain amount of waste and refuse consisting of pits, cores, peels, trimmings, damaged fruit, etc. Unless properly disposed of these offer excellent breeding places for insects which will later contaminate the fruit. Apricot pits when dried have a commercial value. Trimmings from apples and pears can occasionally be used in the production of vinegar or fruit brandy. Other waste products are of little or no value. Pits should be spread out in a layer not more than four inches deep and dried thoroughly in the sun. Other refuse should be spread thinly in the sun on a concrete or other hard surface. Under no circumstances should piles of waste be allowed to accumulate. It should not be spread under trees in the orchard while wet, as drying is very slow. If the refuse is buried, it should be treated with lime or other material to prevent insect growth. Table VII gives the type and amount of waste derived from various fruits.

TABLE VI

RESULTS OF PREPARING AND DRYING ONE TON OF FRESH APPLES, EACH OF VARIOUS SIZES AND GRADES, IN NOVA SCOTIA

Diameter in inches	Number of apples per ton	Grade of apples used	Raw stock after preparation (pounds)	Percent waste	Time to peel and trim (minutes)	Cost to peel and trim (dollars)	Quality obtained	Yield of dried product (pounds)	Selling price (dollars)
1½	42,160	Hand picked	840	58	1506	12.55	Seconds	140	11.20
1¾	26,890	Hand picked	940	52	906	8.00	Seconds	162	12.96
2	17,149	Hand picked	1080	46	642	5.10	Standard	180	18.00
2¼	12,608	Cull	1236	40	450	3.75	Standard	206	20.60
2½	8,913	Cull	1000	50	318	2.65	Standard	166	10.60
2¾	7,261	Cull	1068	47	260	2.17	Standard	178	17.80
3	6,004	Hand picked	1440	28	215	1.79	Standard	240	24.00
3¼	5,118	Hand picked	1490	25½	183	1.52	Choice	248	29.76

TABLE VII

DRYING WASTE OF VARIOUS FRUITS

Fruit	Type of waste	Percent of waste
Apples	Peelings and cores	18-25
Apricots	Pits	6-10
Bananas	Skins	45-50
Cherries	Stems and seeds	8-20
Figs	Culls only	....
Guavas	Seeds	20-45
Grapes	Only culls	....
Nectarines	Seeds	6-12
Peaches (Cling)	Seeds and skins	10-15
Peaches (Freestone)	Seeds	4-6
Pears	Stem and calyx ends	1-2.5
Persimmons	Stems and skins	25-35
Pomegranates	Skins and sector tissues	50-60
Prunes	Only culls	....

41. BLANCHING.—This process is used only in the production of a new product of special quality—blanched dehydrated fruit. The purpose of blanching is to inactivate the enzymes, which cause darkening, and to remove intercellular air. The object is to produce an attractive translucent product of good color. Experimental data indicates that all cut fruits can be blanch-dehydrated; apricots and peaches in this form have been produced commercially. Blanching should take place immediately after cutting before any browning can occur; thirty minutes is the maximum safe delay. Fruits are blanched on cutting trays on which they have been placed after cutting. The fruit is exposed to live steam at a temperature between 190 and 212° F. from 3 to 15 minutes, depending upon variety, until the blanching effect has penetrated the entire depth of the fruit. The blanched fruit should be cooled before sulfuring to secure satisfactory sulfur absorption.

42. SULFURING.—*a.* All cut fruits are exposed to the fumes of burning sulfur before drying. Some figs and sulfur-bleached raisins also are sulfured. Sulfuring acts to preserve both the natural color and the vitamin content of the fruit, and causes sufficient plasmolysis of the cell structure to give a translucent syrupy product in contrast to the dull dark brown fibrous fruit produced by drying without sulfuring.

b. Trays of cut fruit are stacked on a small truck frame generally running on rails, and from one to four trucks are placed in a virtually airtight chamber or sulfur house. Sulfur of the highest purity is burned in a lined pit in the floor at the back of the sulfur house, and the fruit is exposed to the burning sulfur fumes from 2 to 4 hours in the case of grapes and blanched apricots and peaches. Up to as much as 36 to 48 hours are required for unblanched pears, which absorb sulfur dioxide very slowly.

c. Apples are characteristic in that they both absorb sulfur dioxide and lose sulfur dioxide quite rapidly. Sulfuring of apples is frequently done by dipping in sulfite solution. Otherwise, the standard procedure is to pass the apples on a slowly moving belt through a long "sulfur tunnel" in which the sulfur dioxide content is maintained by burning sulfur under forced draft. Because of their low sulfur retention and the ease with which they darken, apples generally are given more than one sulfuring, either by dip or sulfur fumes, from the time they are peeled until they are dried.

43. SUN-DRYING.—*a.* Fruits are dried either in the sun or by artificial heat; those dried artificially may be either dehydrated or evaporated. These three methods of drying are discussed separately.

b. Fruit to be sun-dried almost invariably is dried by the farmer who grows it. Except in the case of raisins, which are dried on trays between rows of vines in the vineyard, an area is set aside as the dry yard. The cutting shed and sulfur houses are adjacent to it. Trucks of fruit on trays are removed from the sulfur house and moved on rails into the dry yard, where the trays are spread in single layers on the ground. In the case of prunes the fruit is spread on trays immediately after dipping, and taken directly to the dry yard. Drying takes from four days to two weeks or more, after which the trays are stacked for the final stage in drying, and after that the fruit is scraped from the trays into boxes.

c. Dry yards offer serious difficulties in the production of quality fruit.

Figure 19.—Typical vineyard scene showing grapes being cut onto trays.

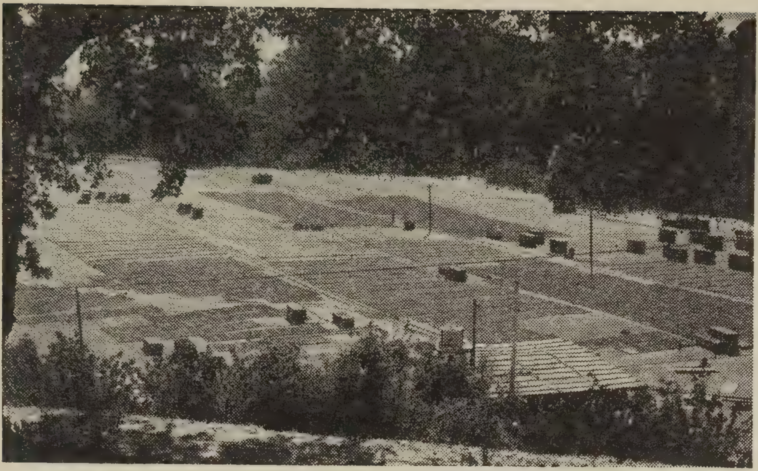


Figure 20.—Large prune dry yard in the Santa Clara Valley. The dipping shed is partially visible in the foreground.

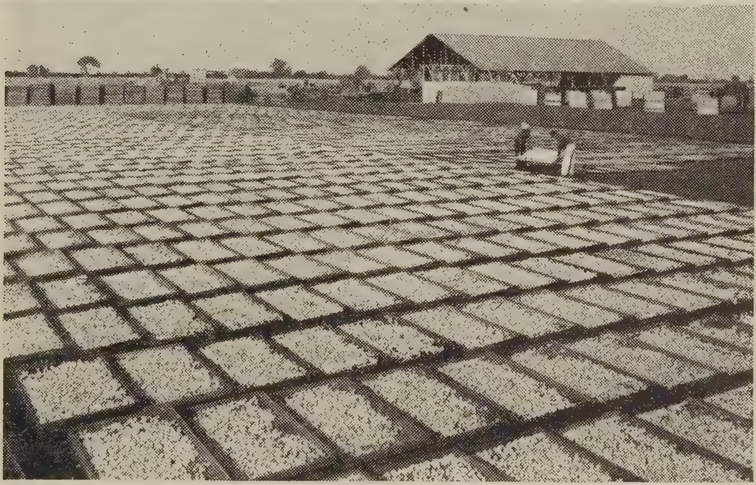


Figure 21.—Fig dry yard. Spreading sulfured Kadota figs.

They are always exposed to unseasonal rains, to dirt from ground and air, and to contamination and attack from insects and domestic and wild animals. The farmer rarely has facilities for adequate sanitation in all stages of dried fruit production.

44. EVAPORATION.—*a.* This term is used to include fruit which is dried by artificial heat with air flow produced by natural draft. Apples are the only fruit dried in this manner. On leaving the dipping tank or

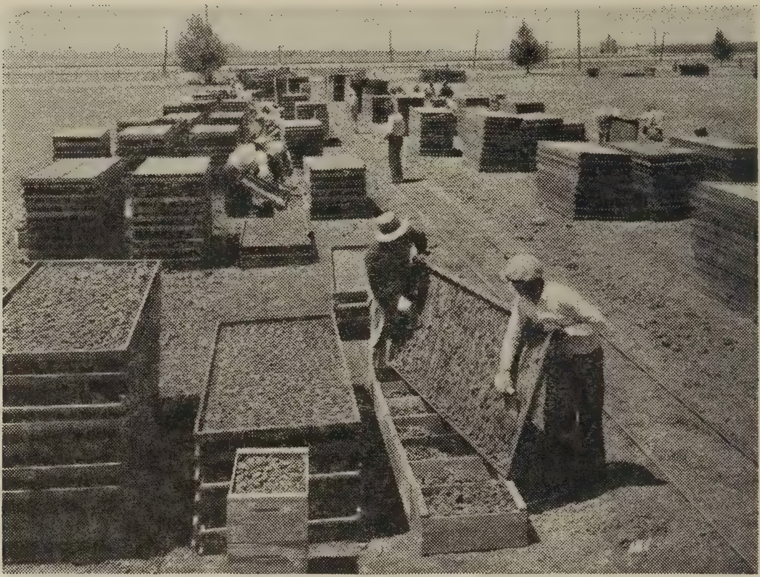


Figure 22.—Transferring dried peaches from trays to boxes.

sulfur tunnel the fruit is deposited on a shaker to remove excess solution adhering to the slices. From the shaker the fruit is either collected in wheel barrows or on trays, depending on the type of drier used. Most dried apples produced in California are dried in kiln evaporators, some in stack evaporators using trays, and very few in air blast dehydrators. In drying apples in kiln evaporators the fruit is ordinarily spread on the floor, from wheel barrows, to a depth of seven to ten inches. The kiln itself is a room about twelve feet square, with a slotted wood floor. With such loading each square foot of kiln surface holds from 25 to 30 pounds of prepared fresh apples which will yield from 5 to 6 pounds of dried fruit. The temperature below the kiln floor will range from 150 to 175° F., and from 100 to 120° F. at the surface of the fruit. Relative humidities in the exhaust air range from 90 percent at the start to 35 percent at the end of the drying period.

b. The fruit is usually turned two or three hours after drying has begun, and every two hours or oftener thereafter. Leaving the fruit undisturbed for the first five or six hours results in a better product with fewer broken rings, according to Caldwell.* When the natural draft system is used, air flow is at a very low rate. In recent years the installation of propeller fans in the outlet flues has increased air flow to about 100 lineal feet per minute.

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* The Bibliography of this manual gives an alphabetical listing of all authors of the original research work cited in this manual.

This has reduced the drying time appreciably. Under ordinary circumstances the drying time is from ten to twelve hours. It is a common practice to burn sulfur in the kiln furnace room so the fruit may pick up sulfur dioxide while drying. It is claimed by operators that this procedure results in better sulfur dioxide retention, and in a product with lighter color.

45. DEHYDRATION.—*a. General.*—This is the term used for the removal of water under controlled conditions of air flow, temperature, and humidity. Several types of dehydrators have been made; each has its own characteristic advantages and disadvantages. These are discussed in Section IV, Principles of Dehydration.

b. Description.—The commonly accepted dehydrator for fruit is a long tunnel through which cars of fruit on trays are either pulled or pushed. The tunnel is generally about 6½ feet wide, 7 feet high, and 40 to 60 feet long. Ordinarily, the tunnel is sufficient to accommodate from 12 to 14 cars holding from 25 to 28 trays, each 3 feet by 6 feet in size.

c. Method of operation.—Depending upon design, air will be blown over the fruit either across the tunnel (cross-current), through the length of the tunnel in the same direction as the flow of fruit (parallel flow), opposite to the direction of the fruit (counter-current), or finally a combination of the parallel and counter flow may be used (two-stage). In order to conserve heat and control humidity, a varying percentage of the air is recirculated, the remainder leaving the tunnel through the exhaust exit.

d. Drying time.—The time required for drying depends upon temperature, humidity, rate of air flow, and character of the fruit, and ranges from about sixteen hours with blanched apricots up to as much as forty hours with unblanched cling peaches and blanched pears.

e. Advantages.—Dehydration offers numerous distinct advantages over sun drying and it is to be expected that increasing quantities of fruit will be dehydrated annually by the use of artificial heat, particularly since the war has given a great impetus to the dehydration of food products in general. Dehydration permits definite control over the product, independent of vagaries of the weather. It is vastly more sanitary and if the fruit is washed before drying, it gives a clean, sterile, completely sanitary quality product. Drying times are reduced, permitting harvesting of all fruit in a shorter time and at optimum maturity. It offers complete independence from spoilage by rain. Blanched dehydrated fruits are a new product, superior in cleanliness, vitamin retention, and other respects, and are the first dried fruits to be produced ready for packaging without further treatment.

f. Disadvantages.—Dehydration offers two disadvantages, each of which is easily overcome. Cut fruits, unblanched, do not have the color produced by sun drying which is now recognized through custom by the industry as the correct color for this product. Sun drying the fruit for several hours before dehydration (an expensive handling procedure) will "fix" this color, but blanching of the fruit before dehydration effects an equally attractive appearance in that a desirable color is preserved in ripe fruits without the bleaching effect of the sun's rays. Whole fruits, particularly prunes, have a tendency to "bleed" or exude syrup during dehydration; this can be eliminated almost entirely by a careful control of the pre-dehydration dipping and the conditions (temperature, humidity, air flow) of dehydration.

46. MOISTURE EQUALIZATION.—Prunes, and to a lesser extent raisins and other fruits, are frequently binned (or boxed) for a period of from one to three weeks immediately after drying or dehydration to "sweat." The necessity and effectiveness of this procedure has not been definitely established. Proponents state that it equalizes the moisture content of all the fruit in the bin, and within each piece of fruit.

47. SIZE GRADING OF DRIED FRUITS.—Size is the prime criterion upon which the industry's quality grades are based (other criteria have been established by government agencies). With the exception of raisins, which are size-graded during processing, all fruits are graded for size before storage. The generally accepted procedure is to pass the fruit over a series of vibrating screens with circular openings of gradually increasing dimensions. The smaller fruit is removed first, and the larger sizes proceed on down to the last screens.

48. STORAGE BEFORE PACKING.—*a.* Blanched dehydrated fruits are not to be stored before packing, and should be packaged in their final container immediately upon leaving the dehydrator. This eliminates all possibility of deterioration incident to storage. Storage is required for most dried fruits because over 500,000 tons are produced annually in California, and this quantity could not possibly be packed as fast as it is produced. Cut fruit, however, amounts to only 60,000 tons per year and, if necessary, most of this could be packed easily in the 90-day production period.

b. Prepacking storage as now practiced is extremely unsatisfactory, and, without exception, results in a decreased quality in the product. Most of this loss of quality could be eliminated by controlled storage, but such controlled storage does not exist today. Deterioration in storage, as outlined by Richert, results from attack by insects, action of microorganisms, chemical action, and mechanical damage. With the exception of raisins and small quantities of other fruits, practically all dried fruit is stored in bins built adjacent to each other with common back and side walls, about 8 by 12 feet in area, filled with dried fruit to a depth of from 5 to 10 feet. These bins are almost impossible to fumigate and insect activity remains virtually uncontrolled. The pressure of the fruit upon the lower layers is so great that the fruit invariably becomes matted into a solid mass and vigorous measures must be taken to break the lumps of fruit into individual pieces. In the case of the more tender fruits (of highest quality) the pressure frequently is great enough to cause a heavy syrup to be exuded from the fruit. Removal from the bins is by pick and shovel, causing further damage mechanically. The complete lack of ventilation within the bins is undesirable.

c. The only satisfactory storage for dried fruits is in clean wooden boxes which are placed in closed chambers or other localities where periodic fumigation is possible. Figs are the only fruit consistently stored in this manner.

d. Raisins are stored in large flat wooden "sweat" boxes, holding about 200 pounds each. It is the accepted practice to store these in stacks up to twenty feet high in the open, under improvised roofs for protection against rain. No facilities whatever are afforded against adverse agents or conditions. One advantage of this storage is the ventilation which is not possible in a closed building.

e. The principal source of damage in fruit is from insects. This is particularly true of figs since restrictions against insect contamination are most rigidly enforced, and because evidence of insect activity within the fruit cannot be removed in later treatment. Insect damage in other fruits is also serious but evidence of insect activity is partially removed in subsequent processing. Without regard to appearance or quality, losses in storage arising solely from the quantity of fruit actually consumed by insects are very significant.

f. Action by microorganisms, particularly yeasts, is evident principally in prunes. The weight of sugar actually consumed is often an appreciable proportion of the total weight of the fruit. Edibility is reduced through a reduction of the sugar content and the introduction of foreign flavors. "Sugaring" of prunes, the development of a surface coating of sugar crystals which must later be washed off and discarded, apparently is associated with yeast activity to some extent.

g. The principal source of damage to cut fruits is the loss of the natural brilliant fruit color. In reality, according to Weast and Mackinney, the loss is caused by a masking of the bright color. The production of very dark colored substances, which may amount to as much as 6 percent of the weight of the fruit, causes this loss of brilliant color. Loss of color is caused by oxidation and a chemical action which involves fruit proteins. This chemical action is accelerated by a low sulfur dioxide content, which in turn is dependent on moisture content. High storage temperatures are important contributing factors.

h. To reduce deterioration in storage, all fruit should have a moisture content of from 18 to 20 percent. Storage temperatures should not exceed seventy degrees, and storage as low as forty degrees is highly desirable. Storage should be in clean wooden boxes. All storage space should be capable of complete fumigation at all times. Rodents attack dried fruit and should be controlled.

49. FUMIGATION.—*a. General.*—Dried fruits are next to cereals in susceptibility to attack and damage by insects. Periodic and thorough fumigation are indispensable control measures. Unfortunately, present practices do not always make them available.

b. Method.—The most satisfactory method of fumigation is in a sealed room; this is seldom available. Stacks of boxed fruit can be fumigated by covering them with an airtight tarpaulin and weighting the tarpaulin to the floor with long narrow sand bags (canvas snakes). Sealing an entire building and fumigating its entire contents is very desirable, but seldom possible. Fumigation of packaged fruits, through the introduction of small amounts of liquid fumigant, has proved very successful. Heavy sprays or fogs of an active fumigant dissolved in mineral oil are widely used in controlling flying insects.

c. Fumigants.—Probably the most satisfactory fumigant for dried fruit is methyl bromide, which presents no fire hazard. Ethylene oxide and mixtures of ethylene oxide with noninflammable chemicals are widely used. Ethylene oxide has been found to be an effective fumigant for yeasts. Cyanide has been supplanted entirely. Chloropicrin is used for some small scale fumigation, particularly by farmers. Isopropyl formate is the best fumigant yet discovered for "in-line" fumigation of packaged fruit.

50. PROCESSING.—*a.* Processing is the treatment given to fruit taken from storage for the purpose of making it more acceptable to the consumer. The functions of processing are to cleanse the fruit, increase the moisture content, and adjust the sulfur dioxide to levels adequate to retain the color and nutrient constituents of the fruit.

b. Cut fruits are washed by passing them through a "recleaner," a horizontal circular iron mesh screen equipped with a series of rotating rubber-tipped wooden paddles which agitate the fruit vigorously. Water is sprayed onto the fruit as it passes through this cylinder. Muir and Lovell peaches are partially peeled in this operation, particularly when the screens are new and somewhat rough. This fruit then feeds onto a shaker where it is sprayed with clean water. It then passes over another shaker to remove residual water, and finally falls onto trays. It is sulfured again, generally remaining in the sulfur house overnight to equalize the moisture content. The trays are emptied onto a long moving sorting belt, from which defective fruit is removed by hand prior to packing. Apples absorb moisture very rapidly and hence can be given only a very light water treatment. They often have to be dried again after processing.

c. Processing of prunes and figs consists of a dip in boiling water for from one to four minutes to wash and sterilize the fruit, make it pliable, and adjust the moisture content to commercial standards. The processor consists of a long tank of boiling water through which buckets of fruit pass on an endless chain. Upon leaving the processor, prunes pass over a shaker to remove excess water, and are hand-sorted to remove defective pieces. The prunes are packed into boxes or cartons while hot. Figs are allowed to cool somewhat, after which they must pass a 100 percent inspection for insect or other damage. Each fig is cut about halfway in two and the interior is examined. The fig is then pressed into bars of various sizes, or ground into fig paste for baking uses. Whole figs are packed from lots which have passed a rigid inspection before processing.

d. The first step in raisin processing is to remove the stems and foreign particles by passing the fruit over slotted vibrating screens. A blower removes empty berries and leaf particles. Adhering dust is removed by a light water wash. Cap stems, the small stems adhering to individual berries, are removed by passing the fruit between a rapidly revolving wire mesh screen, and an outside casing for the screen. Muscat raisins are dried to a low uniform moisture content before capstemming, and are then returned to their normal moisture content for seeding. Seeds are removed by passing the raisins between two rollers, one of soft rubber and the other with closely set dull prongs which push the seeds out of the berries. Most seeded raisins are given a light dip in vegetable oil to produce a free-flowing product.

51. PACKING.—Blanched dehydrated fruits are packed in cartons holding one and one-half pounds, and twelve of these cartons are packed in a larger "arsenal-type" carton which is waterproofed by a double dip in melted wax. Two of these cartons are packed in a wooden box. This type of packing also has been specified for raisins, (three 7-pound cartons in one large carton) and dehydrated prunes. The industry's most widely accepted procedure is to pack the fruit in boxes which contain 25 pounds. The boxes are of wood, and the fruit partially protected by a layer of glassined paper. Raisins are packed in 1-pound paper cartons, in 2- and 4-pound cellophane bags, and in 25-pound boxes. One and

2-pound moistureproof paper cartons are becoming increasingly popular with prunes and to some extent with cut fruits.

52. STORAGE AFTER PACKING.—*a.* Practically all dried fruits are packed only upon order so there is almost no storage of packed fruit within the packing plant. Packaged fruit is susceptible to all the hazards listed for dried fruits, and must particularly be protected against insect contamination. Storage at temperatures from 40 to 50° F. is recommended by the industry because insect activity and other forms of deterioration (*i. e.,* loss in color) are arrested by these temperatures. It has been found that the rate of loss of color doubles for every 10° F. increase in storage temperature.

b. For a number of years the industry has recommended that brokers and distributors place any fruit on hand between May 1 and October 1 in cool storage, primarily as a means of protection against insects. Barger has studied the effect of cold storage conditions on the keeping of dried fruit and has shown that exposed apples, peaches, figs, and prunes of 20-25 percent moisture remain nearly constant in weight in an atmosphere of 75 percent relative humidity, and that raisins of 14 to 16 percent moisture change slowly with a relative humidity of 50 to 60 percent at temperatures of 32 or 50° F.

PRODUCTION PROCEDURES APPLICABLE TO INDIVIDUAL FRUITS

53. APRICOTS.—*a. Harvesting.*—Pick from tree when fully ripe; about three pickings per season.

b. Fresh fruit storage.—Absolute minimum; not over 12 hours.

c. Washing.—Recommended; seldom practiced.

d. Peeling.—None.

e. Dipping.—None.

f. Cutting.—Cut around suture and remove pit.

g. Waste disposal.—Essential for pits and refuse.

h. Blanching.—Followed only for very minor production of dehydrated fruit.

i. Sulfuring.—Up to six hours required.

j. Sun-drying.—In farmer's dry yard.

k. Dehydration.—For extremely minor production only.

l. Moisture equalization.—Incidental to storage.

m. Size-grading.—In packing plant before storage.

n. Storage.—In open bins.

o. Fumigation.—Seldom fumigated before packing.

p. Processing.—Wash, reclean, re-sulfur, and hand-sort.

q. Packing.—Generally in 25-lb. wooden box; also in 1-lb. cartons.

54. PEACHES.—*a. Harvesting.*—Pick from tree when fully ripe; about three pickings per season.

b. Fresh fruit storage.—Absolute minimum; not over 12 hours.

c. Washing.—Recommended for sun-dried fruit; seldom practiced. Thorough washing after lye-peeling of clings is essential.

d. Peeling.—None for freestones. Clingstones lye-peeled.

e. Dipping.—None, except lye-peeling of clings.

f. Cutting.—Cut around suture and remove pit.

g. Waste disposal.—Essential for pits and refuse.

h. Blanching.—Only for small production of some dehydrated fruit.

i. Sulfuring.—About six hours for freestones, two to four hours for blanched clings, up to 8 hours for unblanched clings.

j. Sun-drying.—In farmer's dry yard for freestones. Very few clings sun-dried.

k. Dehydration.—Almost never for freestones. Almost always for clings.

l. Moisture equalization.—Incidental to storage.

m. Size-grading.—In packing plant before storage.

n. Storage.—In open bins.

o. Fumigation.—Seldom fumigated before packing.

p. Processing.—None required for blanched dehydrated fruit. Others wash, reclean and partially peel, resulfur, hand-sort.

q. Packing.—Pack blanched dehydrated fruit into cartons direct from dehydrator. Other peaches generally in 25-pound wooden box.

55. PEARS.—*a. Harvesting.*—Pick from tree before maturity is reached.

b. Fresh fruit storage.—From four to fourteen days. Sort frequently and remove ripe fruit. Cool storage preferred.

c. Washing.—Thorough washing essential to remove spray residue.

d. Peeling.—None, except mechanical peeling for some dehydrated fruit.

e. Dipping.—None except in washing.

f. Cutting.—Cut in half along long axis. Core removal recommended but seldom practiced.

g. Waste disposal.—Essential for peels and trimmings.

h. Blanching.—Only for very minor production of dehydrated fruit.

i. Sulfuring.—Up to 48 hours for unblanched fruit.

j. Sun-drying.—In farmer's dry yard.

k. Dehydration.—For very minor production only.

l. Moisture equalization.—Incidental to storage.

m. Size grading.—In packing plant before storage.

n. Storage.—In open bins.

o. Fumigation.—Seldom fumigated before packing.

p. Processing.—Wash, reclean, resulfur, hand-sort.

q. Packing.—Generally in 25-pound wooden box.

56. APPLES.—*a. Harvesting.*—Pick from tree when fully ripe.

b. Fresh fruit storage.—Will withstand normal storage periods. Reduced temperatures preferred.

c. Washing.—Not required as all apples are peeled and cored.

d. Peeling.—All apples peeled and cored mechanically.

e. Dipping.—None, except occasional dipping of peeled fruit in sulfite solutions.

f. Cutting.—Cut into slices or segments after peeling.

g. Waste disposal.—Essential for peels, cores, trimmings.

h. Blanching.—None.

i. Sulfuring.—Often done with sulfite solutions, or about one hour in tunnel under forced draft.

j. Sun-drying.—None.

k. Dehydration.—Virtually none. Practically all apples dried by *evaporation:* artificial head without controlled air flow and humidity.

l. Moisture equalization.—In bins for a few days immediately after drying.

m. Size grading.—Screen to remove small pieces only.

n. Storage.—In 50-pound boxes, or burlap sacks.

o. Fumigation.—Seldom fumigated before packing.

p. Processing.—Very light wash, resulfur, occasionally redry, handsort.

q. Packing.—In 25-pound wooden box.

57. GRAPES (RAISINS).—*a. Harvesting.*—Pick from vines at full maturity.

b. Fresh fruit storage.—None for sun-dried raisins. Not over twelve hours for dehydrated grapes.

c. Washing.—None for sun-dried. Essential after lye-dipping for dehydration.

d. Peeling.—None.

e. Dipping.—None on normal sun-dried. Dehydrated bleached raisins given light dip in hot weak lye to "check" skins. Small special production given short dip in soda solution for "natural" color.

f. Cutting.—None.

g. Waste disposal.—None.

h. Blanching.—None.

i. Sulfuring.—Two to four hours for production of bleached raisins only.

j. Sun-drying.—On trays in vineyard between rows of vines.

k. Dehydration.—For small production of bleached raisins only.

l. Moisture equalization.—Effected during normal storage.

m. Size grading.—During processing operations after storage.

n. Storage.—In large boxes, in open.

o. Fumigation.—Impossible in open storage.

p. Processing.—Remove stems and trash; wash lightly; remove capstems. With muscats, dry to low moisture before capstemming; capstem; remove seeds; oil spray optional.

q. Packing.—Into 1, 2, and 4-pound cartons and bags; and in 25-pound wooden or fiberboard box.

58. PRUNES.—*a. Harvesting.*—Pick fallen ripe fruit from ground. Generally two pickings per season.

b. Fresh fruit storage.—Hold to minimum; not over 12 hours.

c. Washing.—Essential after lye-dipping.

d. Peeling.—None.

e. Dipping.—All prunes given light dip in warm water or lye solution to "check" skins to facilitate drying.

f. Cutting.—None.

g. Waste disposal.—None.

h. Blanching.—None.

i. Sulfuring.—None, except for very limited production of "silver" prunes.

j. Sun-drying.—In farmer's dry yard.

k. Dehydration.—Approximately 40 percent of crop in California, 100 percent in Pacific Northwest.

l. Moisture equalization.—Customary practice, for several days before delivery to packing plant.

m. Size grading.—In packing plant before storage.

n. Storage.—In bins or burlap sacks.

o. Fumigation.—Seldom fumigated.

p. Processing.—Two to five minute dip in boiling water.

q. Packing.—Pack hot from processor into 25-pound wooden box, or 1- and 2-pound cartons.

59. FIGS.—*a. Harvesting.*—Pick ripe partially dried fallen fruit from ground. At least two or three pickings per week.

b. Fresh fruit storage.—None.

c. Washing.—Light washing recommended when further drying is required.

d. Peeling.—None.

e. Dipping.—None.

f. Cutting.—None, except final stage in processing when making fig bricks.

g. Waste disposal.—Essential to remove and destroy cull fruit.

h. Blanching.—None.

i. Sulfuring.—Green Kadotas always sulfured before sun-drying. Other figs occasionally given light sulfuring, but not required.

j. Sun-drying.—Occasionally required. Dry-yard used.

k. Dehydration.—Virtually none.

l. Moisture equalization.—Incidental to storage.

m. Size grading.—In packing plant before storage.

n. Storage.—In boxes or sacks in closed bins.

o. Fumigation.—Frequent fumigation at all stages.

p. Processing.—Two to four minute dip in boiling water. Cut by hand, inspect, and mold into bricks; or pack whole; or shred and grind to paste.

q. Packing.—Fig bricks cellophane wrapped and packed in small wooden box. Fig paste in 25-pound wooden box.

PRINCIPLES OF DEHYDRATION

60. GENERAL.—Drying by artificial heat depends upon a number of factors which can be controlled. Scientific control is essential for high quality and economy of operation. Some of the factors involved in efficient dehydrator operation are presented in this section.

61. HEAT.—*a.* The heat applied to the fruit is the medium responsible for the evaporation of moisture. The unit of measurement of heat is the Btu (British thermal unit). One Btu is the heat required to raise the temperature of one pound of water one degree Fahrenheit. Approximately 970 Btu's are required to evaporate one pound of water, plus an additional 130 Btu's which are required to bring it to the temperature of evaporation, making a total of about 1100 Btu's necessary to evaporate one pound of water from fruit entering the dehydrator.

b. A gallon of Diesel fuel oil, the common source of heat for most dehydrators, will furnish roughly 133,000 Btu's. Thus at operations of 100 percent efficiency, each gallon of fuel oil would evaporate 133,000/1100, or 121 pounds of water. But dehydrators, for a number of reasons, do not operate at 100 percent efficiency. The efficiency of a dehydrator may be determined by using the formula:

$$\text{Percent efficiency} = 100 \times \frac{\text{lbs. water evaporated} \times 1100}{\text{gal. fuel oil used} \times 133{,}000}$$

c. Heat may be applied to the fruit by direct heat, in which the products of combustion are used directly, by direct radiation, in which heat is absorbed from burning fuel, by direct radiation through the furnace walls, flues, or radiators, or by indirect radiation. In indirect radiation heat is generated at a distant point and conveyed to the point at which air is to be heated by means of steam or hot water. This latter method is seldom used.

62. HUMIDITY.—*a.* Humidity is a measure of the moisture content of the air. Relative humidity is expressed in percent and is the fraction of water present in the air as compared with the amount of water in saturated air at that same temperature. Absolute humidity is expressed in pounds per cubic foot and is the actual weight of water in a given volume of air, regardless of temperature. At a given definite absolute humidity, the relative humidity will decrease as the temperature increases, and increase as the temperature decreases. Both relative and absolute humidity are determined from psychrometric charts. Humidity measurements are based upon temperature as normally measured and the "wet bulb" temperature, which is the reading on a thermometer whose bulb is covered with a wick from which water is evaporating freely. Inasmuch as the evaporation of

water has a cooling effect, the wet bulb temperature will be lower than the normal temperature, except in saturated air in which both temperatures are the same.

b. Relative humidity is used to express the tendency of the air to absorb additional moisture. Water will evaporate into air of low humidity considerably faster than it will into air of high relative humidity, regardless of the absolute humidity. Absolute humidity is the actual weight fraction of water in air, and is used in calculations regarding the weight of water removed from the fruit during dehydration.

63. AIR FLOW.—Air has two main functions in drying; it conveys heat to the product to be dried and carries away the moisture evaporated from the product. In drying fruits, several times as much air is required to transport heat to the product as to transport the moisture evaporated from it. In a typical example with fruit, seven times as much was required. A continuous and fairly rapid flow of air is essential to remove the evaporated moisture after it has left the fruit. If the moisture is not removed, the relative humidity immediately surrounding the fruit reaches a high level and further evaporation is appreciably decreased. A linear air flow between 500 to 1000 feet per minute should be maintained at all times.

64. TEMPERATURE.—*a.* Moisture will evaporate more rapidly at high than at low temperatures, so temperatures must be maintained high enough to maintain efficient evaporation, but must not reach a temperature that will scorch or otherwise damage the fruit. The temperature of the fruit itself will depend on the amount of heat supplied and also upon the amount of evaporation, as evaporation absorbs heat and lowers the temperature.

65. CRITICAL TEMPERATURE.—This is the temperature which cannot be exceeded during the last stages of drying without damaging the fruit by heat, through scorching, caramelization, or otherwise. The critical temperature varies with different fruits. At high moisture contents the critical temperature can be exceeded, because the high moisture protects the fruit from heat and evaporation cools the fruit. Table VIII lists the critical temperatures for several fruits.

66. CASE-HARDENING.—When moisture is removed from the surface of the fruit at a faster rate than additional moisture can be diffused to the surface, the surface will become quite dry while the interior of the fruit remains moist. When this condition proceeds to the point that the fruit develops an almost impervious dry surface, the fruit is said to be case-hardened. It is very difficult to dry case-hardened fruits as the surface forms a seal through which it is almost impossible to transmit moisture.

TABLE VIII

CRITICAL TEMPERATURES FOR FRUIT DEHYDRATION

Fruit	Critical Temperatures
Apples	160° F.
Apricots	155° F.
Cherries	160° F.
Figs	150° F.
Nectarines	155° F.
Peaches, Cling	155° F.
Peaches, Freestone	155° F.
Pears	140° F.
Prunes	165° F.
Raisins	155° F.

Case-hardening is prevented by lowering the drying temperature or increasing the humidity of the air. Of all fruits, prunes case-harden most readily, while some other fruits do not do so at all.

67. RECIRCULATION.—After the warm air has passed over the fruit and absorbed moisture a portion of it is exhausted from the dehydrator, and the remainder is mixed with fresh air and again passed over the fruit. This reuse of the air is termed recirculation. There are two reasons for recirculation: control of humidity, and economy. Fresh air entering the dehydrator will have, after heating, a very low relative humidity and may cause case-hardening unless mixed with air of higher humidity. Also, the air that has passed over the fruit still contains a considerable degree of heat which would be lost entirely if not used again. Dehydrator efficiency would be reduced if the air were not used again.

68. MOISTURE CONTENT.—The moisture content of the fruit is expressed in percent and represents the portion of the total weight of the fruit which is water. Dehydration is stopped when the moisture content falls to a certain predetermined level.

69. MOISTURE CONTENT ON MOISTURE-FREE BASIS ("T").—*a.* At times the simple expression of the moisture content does not give an adequate picture for comparison purposes. This comparison can be obtained by representing moisture content per unit weight of moisture-free solids, termed "T." Thus in a product of 50 percent moisture T will be 1.00, as there is just one part of water to one part of solids; all dried fruits, in that they contain less than 50 percent moisture, will have a T value less than one, whereas fresh fruits, having more than 50 percent moisture will always have a T value greater than one. T values for some fruits are given in table IX.

TABLE IX

MOISTURE CONTENT, AS T, OF THE EDIBLE PORTION OF SOME FRUITS

Fruit	Moisture Range (T)
Apples	4.56 to 6.14
Apricots	4.88 to 6.14
Grapes	4.00 to 4.88
Peaches	4.88 to 8.09
Pears	4.56 to 5.67
Prunes	2.33 to 4.00

b. As an example of the practical application of T, consider a 100 pound lot of fresh fruit entering a dehydrator. This fruit contains a certain weight of solid matter which will not vary throughout the dehydration. However, the total weight of fruit, the weight of water in the fruit, and the moisture content will vary. The T value at different stages of dehydration will give an accurate comparative value for the weight of water evaporated from this constant weight of moisture-free fruit.

c. The relationship between moisture content and T is shown by the formula

$$T = \frac{M}{100 - M}$$ where M is the moisture content of the fruit.

d. The relation between moisture content (M) and moisture on moisture free basis (T) is shown in table X for the range from 1 to 90 percent moisture.

TABLE X

RELATION BETWEEN MOISTURE CONTENT ON WET AND DRY BASIS

M	T	M	T	M	T
90%	9.0	60%	1.50	15%	.177
85%	5.85	50%	1.00	10%	.111
80%	4.00	40%	.67	5%	.053
75%	3.00	30%	.43	3%	.031
70%	2.33	20%	.25	1%	.010

70. DRYING RATIO.—*a.* The drying ratio of fruit is the ratio of the weight of the fresh fruit to the weight of that same fruit after drying. It is a very convenient rule of thumb used in calculating the weight of dried

product that will be obtained from a given weight of fresh fruit. The drying ratio, of course, varies with the moisture content of both the fresh and the dried fruit, and hence is not a constant. Since the moisture contents of both fresh and dried fruit vary only slightly, the range of the drying ratio value for any given lot of fruit is relatively small. However, the drying ratio varies materially for different fruits, for varieties of the same fruit, and for varying degrees of maturity.

b. Some fruits are peeled, pitted, or trimmed before drying or dehydrating. These fruits accordingly will have two separate drying ratios: one for the whole fruit (over-all), and another for the fruit after it has been prepared for drying (actual). The over-all drying ratio is the one commonly employed. Table XI gives the approximate drying ratios for some fruits.

TABLE XI

DRYING RATIOS FOR SOME FRUITS

Fruit	Over-all Drying Ratio
Apples	7.0:1 to 8.5:1
Apricots	4:1 to 7.5:1
Cherries (Sweet)	2.2:1 to 3.7:1
Figs (Partially dry)	1.3:1 to 2.0:1
Grapes	3:1 to 6:1
Peaches, Freestone	4:1 to 8:1
Peaches, Clingstone	6.5:1 to 10:1
Pears	4.5:1 to 6.0:1
Prunes	2.1 to 3.5:1

71. DEHYDRATOR DESIGN.—*a.* Dehydrators are built according to several basic designs, as well as to variations and refinements in each design. The *kiln* is discussed fully in the section on Production Procedures (evaporation). It consists of a closed room with a slotted floor upon which the fruit is dumped. Heat from below passes up through the floor and the fruit, and out through the stack, either by natural draft or with the aid of a blower.

b. The *cabinet type* consists of a closed chamber or cabinet which is filled with trays of fruit. The entire cabinet is kept at a constant temperature, and air is circulated across or through the trays by forced draft. This type is unsatisfactory except for very small lots, as the fruit requires constant attention and trays must be rearranged frequently to effect uniform drying.

b. The *stack* consists of a tower in which trays are arranged one above the other. The trays of fresh fruit enter at the top, and are removed at the bottom. Hot air enters the bottom and leaves at the top, passing through the trays moving in an opposite direction.

c. The *tunnel drier* has been found most satisfactory of all types for fruits. Trays of fruit are stacked on cars running on rails (generally) through a long tunnel. Hot air passes over the trays either along the length of the tunnel or across the tunnel.

d. Spray drying and drying within heated rotating cylinders are not applicable to fruits. Some special products such as apple nuggets are dried under vacuum. Some cranberry fruit flakes are produced by drying on the outside surface of a revolving heated drum. In a few instances (*i. e.*, muscat raisins before capstemming) belt driers are used for finishing or redrying.

72. METHOD OF AIR CIRCULATION.—*a.* The characteristics and unsatisfactory aspects of natural draft are discussed under Production Procedures (section II). The means of circulation listed below apply to tunnel type dehydrators.

b. Cross flow circulation is the passage of air over the fruit across the breadth of the tunnel.

c. Counter current air flow is the system in which air passes through the length of the tunnel opposite to the direction traveled by the fruit.

d. In the *parallel current air flow* the fruit and the air travel in the same direction.

e. The *center inlet* dehydrator is designed to have the air enter at the center of the tunnel and pass in opposite directions to the two ends of the tunnel. Thus the fruit entering the tunnel is subjected to a counter current during the first half of the drying period, and a parallel current during the last half.

f. The *center exhaust* is the direct opposite to the center inlet system. Air enters the two ends, passes over the fruit, and is removed at the center of the tunnel.

73. DEHYDRATOR OPERATION.—*a.* The following twelve points are enumerated for the practical dehydration of fruit in a tunnel dehydrator:

(1) The total weight of air moving through the dehydrator equals the air flow in lineal feet multiplied by the tunnel cross section in square feet, all divided by 16. This equation is derived from the fact that air flow multiplied by cross section gives cubic volume, and there are approximately 16 cubic feet of air per pound.

(2) For each five degree drop in dry bulb temperature along the tunnel length one pound of air (calculated as above) will pick up about 0.001 pound of water vapor. The number of pounds of water evaporated per

minute is approximately one-fifth the temperature drop through the tunnel multiplied by 0.001 and again multiplied by the number of pounds of dry air circulating per minute.

(3) In a well insulated tunnel the wet bulb temperature should remain practically constant along the length of the tunnel.

(4) Exact humidity calculations can be made with the aid of a complete psychrometric chart.

(5) The temperature at the dry end of a dehydrator is determined by the critical temperature of the fruit that is being dried.

(6) At the cool (or wet) end of the tunnel the dry bulb should be at least 15 degrees above the wet bulb temperature.

(7) The total number of cars forming the stationary load of the tunnel is conditioned by points 5 and 6 above, and by the nature of the fruit. It must be determined experimentally.

(8) The wet bulb temperature is determined largely by the amount of recirculation. The more air recirculated the higher the wet bulb temperature will be.

(9) Fruits which dry rapidly, such as apples, blanched apricots, and blanched peaches, have a great temperature drop through the tunnel. For these fruits little air should be recirculated. Otherwise the number of cars per tunnel must be kept small. Fruits that dry slowly and have some tendency to case-harden (for example: prunes, raisins, or blanched clingstone peaches) have a small temperature drop through the tunnel and as much as 75 percent of the exhaust air may be recirculated.

(10) The use of cars which carry a double tray stack is objectionable because of awkward handling. Their heavy weight may also result in uneven drying, particularly in the case of fast-drying fruit. If these cars are used, it is often necessary to turn the end car on a turntable outside the tunnel.

(11) *(a)* The starting up or emptying of a tunnel requires particular attention depending on the system of air flow. In starting a counter current air flow tunnel the first car introduced will be exposed directly to dry hot air instead of cool moist air as is the case after dehydration is well under way. Two starting procedures may be used. If the product shows no tendency to case-harden, it is permissible to expose the first cars to hot dry air. These cars will dry faster than those drying under normal conditions, and must be removed after a shorter drying period in order to prevent overdrying and scorching. Emptying of a counter current tunnel does not offer any particular difficulties since each car progresses in a normal manner. In case recirculation is used, the only change occurring is a slow drop

in wet bulb temperature because of the fact that a decreasing amount of air is recirculated. This drop will normally cause no trouble.

(b) In a parallel current dehydrator the starting up of a tunnel offers no complications since each car progresses in a normal manner. In case of recirculation the wet bulb may gradually rise and when it reaches the desired level recirculation must be reduced. Emptying a parallel flow tunnel requires special attention because the last car introduced will not be exposed to the protective action of wet cars in back of it, but on the contrary will be exposed to high temperatures throughout the tunnel. In this case the temperature must be dropped each time another car would normally have been introduced, until the critical temperature of this fruit has been reached.

(c) The picture of requirements for starting and stopping a two-stage drier can be deduced from the foregoing since it is a combination of the parallel and the counter flow systems.

(12) A very important point in drying is to size grade the green fruit so that cars with large and small fruits are not mixed in one tunnel. The drying time for large and small fruit may vary by several hours and a car of small fruit behind a car of large fruit may be overdried and scorched before that of the large fruit is dry.

TYPES AND VARIETIES

74. GENERAL.—*a.* A convenient general classification of dried and dehydrated fruits is based upon methods of preparing and handling, nutritional characteristics, and appearance. This classification establishes two groups: cut fruits and whole fruits. These groups are described in detail in sections VI and VII. Other fruits which have been dried experimentally or on a small scale are described in section VIII.

(1) Cut fruits, as the name implies, are those which are cut into halves or other pieces prior to drying or dehydration. The principal fruits which are halved are apricots, peaches, pears, and nectarines. Apples are peeled and cored, then cut into halves, quarters, or slices. Apples vary widely from other cut fruits in all their characteristics and are more appropriately considered a subsidiary to the general classification of cut fruits.

(2) Whole fruits are those which are dried or dehydrated without any prior segmentation. Prunes are the typical example of this class. The few cherries that are dehydrated are handled in a manner very similar to prunes, whereas figs, another whole fruit (often cut after drying) require their own characteristic methods of handling.

(a) Raisins, which constitute about one-half of the entire dried fruit production, have distinctive handling methods which are not used with any other fruits.

SECTION VI

CUT FRUITS

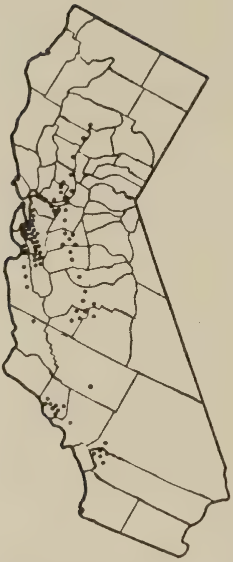

Figure 23.—Distribution of apricots in California (one dot equals 1000 acres).

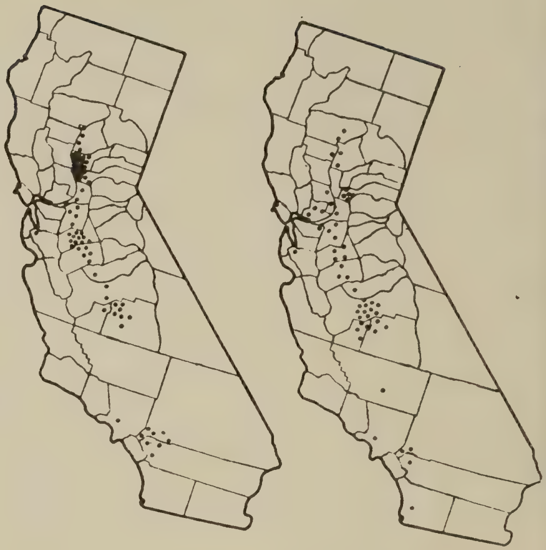

Figure 24.—Distribution of peaches in California (one dot equals 1000 acres). Left, clingstone; right, freestone.

75. APRICOTS.—*a.* There are four principal varieties grown for drying and dehydration:

(1) *Blenheim.*—This variety is medium in size, oval shape, and a golden-orange color; the flesh is juicy and rich; the tree is very productive, and the fruit ripens uniformly. It is very popular for drying, especially in the coast counties (Santa Clara, Alameda, Napa, San Benito, Sonoma). It unquestionably produces the best dried apricot.

(2) *Royal.*—The Royal is small to large in size, oval in shape, and a dull yellow color tinged with orange. It is very firm and juicy. This variety is not as popular for drying as Blenheim, but is packed extensively in Southern California and in the hot interior valleys. It is often considered to be a sub-variety of the Blenheim.

(3) *Moorpark.*—This is a very large, round, reddish orange variety, tinged with dark yellow and brown specks. It is fleshy, sweet, juicy, and somewhat fibrous. It does not ripen uniformly except in the Santa Clara Valley where it is a popular variety.

(4) *Tilton.*—The Tilton is medium in size, oval and yellow or orange in color. The pit cavity (dried) is often white and may be fibrous rather than juicy but is very sweet. This variety is grown almost exclusively in the San Joaquin Valley.

b. The normal production of dried apricots is from 30 to 35 thousand tons annually. Since 1940, however, the annual production has fallen to about one-half this figure. This has been caused in part by the increased demand for the canned product and partly by a smaller crop yield. The principal producing center is the Santa Clara Valley, with additional production in the interior valleys and a considerable acreage in Southern California.

76. PEACHES.—*a.* Peaches are normally divided into two groups: freestones and clingstones (or clings). As the name implies, the classification is based upon the ease of removal of the pit. In the freestones the pit is removed by hand with no difficulty as soon as the peach is cut in two. With the clingstone the pit must be cut from the meat of the peach, either mechanically or by hand, with a special spoon-shaped knife. The clingstone has a much firmer texture and is the accepted peach of the canning industry. The freestone has a more delicate texture and is produced primarily for drying. The dried freestone is quite firm and does not have the toughness of the clingstone. Both types are distributed widely as fresh fruit. The varieties of peaches used for drying include:

(1) *Muir.*—These produce the best dried peaches and are grown almost exclusively for this purpose. The dried product is thick, sweet, and of a uniform nonfibrous texture. The color is very definitely yellow. In processing operations before packing they are easily peeled; this fact is often included in the commercial description.

(2) *Lovell.*—This variety is second only to the Muir in its popularity as a dried fruit. It is yellow in color, of excellent flavor and texture, and generally somewhat larger than the Muir.

(3) *Elberta.*—This is an ideal fresh peach but is dried to a great extent because of the inability of the fresh market to absorb the entire production. The fruit is large and somewhat more fibrous than the Lovell and Muir. This peach has a characteristically large, red pit cavity.

(4) *J. H. Hale.*—This is another fresh variety which is often dried. Numerous other varieties, grown in lesser quantities, are also dried when not utilized in the fresh fruit market.

b. Varieties of clingstone peaches which are dried depend almost entirely upon surpluses from the canning industry. Variations among varieties are slight. The cling peach is almost invariably dehydrated rather than sun-dried.

77. NECTARINES.—The nectarine is a cross between a plum and a peach. The pit is almost identical in appearance with that of a peach. There are both freestone and cling varieties, although the cling is almost never dried. The size is that of a small peach. Production of dried nectarines is comparatively small, although the dried product is rich and tasty and has an attractive appearance. Some of the more common varieties dried are Hardwick, Newboy, Quetta, and Stanwick.

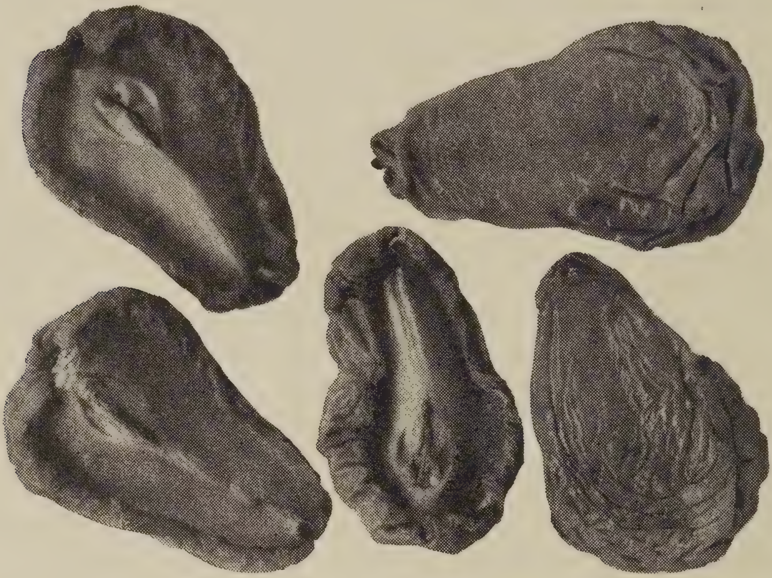

Figure 25.—Sun-dried pears.

78. PEARS.—The Bartlett pear is the only one dried on a commercial scale although several other important varieties are grown for use as fresh fruit and for canning. The Bartlett is also an excellent canned and fresh pear. The d'Anjou is the only other variety that results in a high quality product when dried. Varieties such as the Bosc, Du Comice, Hardy, Winter Nellis, Easter Beurre, and Kieffer can be dried easily, but the finished product is hardly suitable for commercial trade channels.

79. APPLES.—Apples are produced in large quantities and over a larger area than any other tree fruit. They have a longer harvesting and drying period than any other dried fruit. Apples are unlike most dried

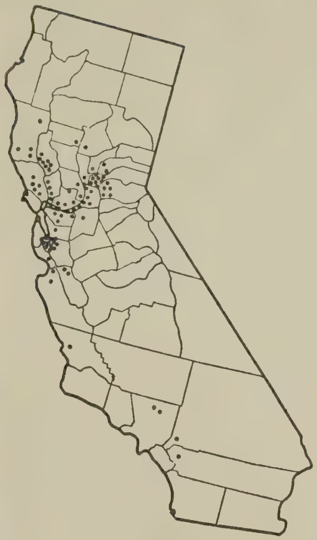

Figure 26.—Distribution of pears in California (one dot equals 1000 acres).

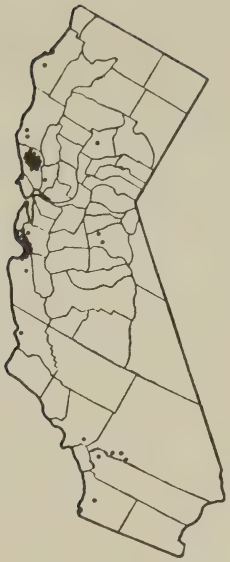

Figure 27.—Distribution of apples in California (one dot equals 1000 acres).

fruits in that in normal times they are practically always produced as a by-product.

b. A number of varieties of apples are suitable for drying. The more desirable varieties should be regularly shaped and smooth to minimize loss in peeling and trimming. A firm texture is desirable to reduce preparation losses and to give the best possible appearance to the finished product. The color of the skin is important since it has a direct effect on the efficiency of preparation. Yellow or green skin is preferred since traces of skin left on the fruit do not mar its appearance as much as when the skin is red. The color of the flesh may be either white or creamy since trade preference on this point is divided.

c. Different varieties are frequently mixed after drying, although this practice is strongly undesirable. Low prices of the dried product and the necessity of utilizing varieties which yield mediocre quality fruit have encouraged the practice of blending. Different varieties require different degrees of cooking and the color of the flesh varies considerably so that mixing reduces the desirable uniformity of appearance.

d. In California about equal quantities are produced in Santa Cruz and Monterey Counties, centering in Watsonville, and in the Sebastopol district in Sonoma County. A small amount is also dried in Anderson Valley in

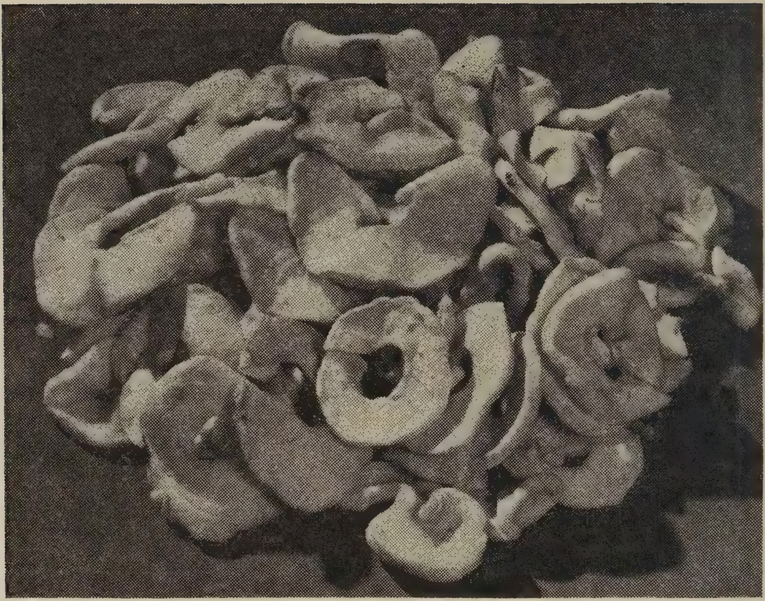

Figure 28.—Dried apple slices (or rings).

Mendocina County. The Newton Pippin is the one most commonly dried in the Watsonville area, and the Gravenstein in the Sebastopol area. The Bellflower, which is produced principally in the Watsonville district, ranks third; others of importance are the Baldwin, Delicious, Hoover, Jonathan, King, Permain, Rhode Island Greening, Roman Beauty, Wagener, and Winesap. Allen has discussed the characteristics of these varieties.

SECTION VII

WHOLE FRUITS

80. RAISINS.—*a.* Two varieties of grapes account for fully 95 percent of California's raisin crops, with an additional two varieties accounting for the remaining 5 percent. Other grape varieties can be and have been dried, particularly during the prohibition era, but these cannot be classed correctly as raisins.

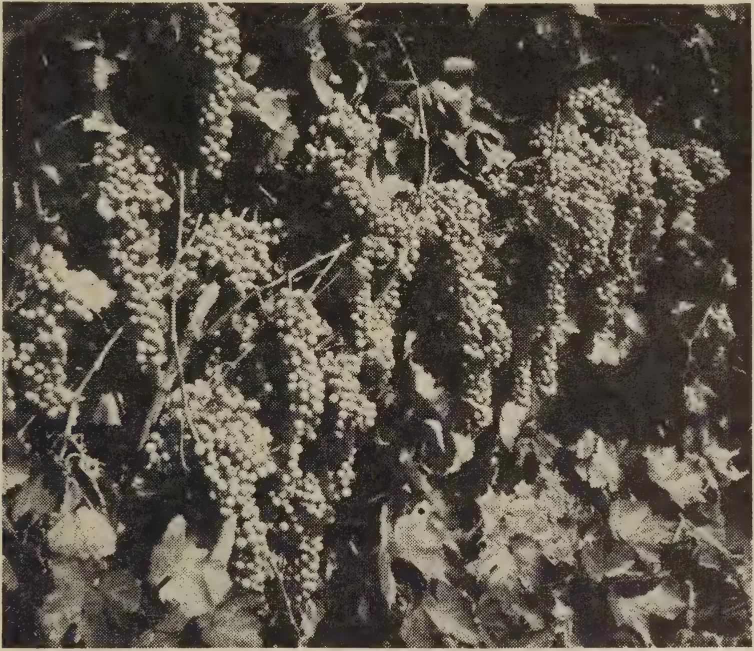

Figure 29.—Ripe Thompson Seedless grapes ready for picking.

(1) *Thompson Seedless (Sultanina).*—When ripe the fruit is yellowish-green, oval in shape, and of medium size. When dried the skins are tough but the flesh is fairly juicy and quite meaty and sweet. It is seedless although the very large berries occasionally do show a small but entirely unobjectionable seed form. It is an excellent table grape and, although a poor wine grape, it is widely used for producing fortifying brandy and certain wine types. The vines are exceptionally heavy producers.

(2) *Muscat (Muscat of Alexandria).*—When fully ripe the fruit is quite large, round, and of an amber or amber-green color. When dried the skins are tough and thick. The flesh is meaty, sweet, and fairly juicy. The flavor

is rich and spicy, and the color an amber-brown. There are from one to four seeds in each berry. This is a poor shipping variety but is extremely important in the production of Muscatel wine.

(3) *Sultana.*—The fruit is medium in size and when fully ripe has a yellowish-green color. The flavor is sweet but rather neutral. This was formerly an important raisin producer but has been supplanted almost entirely by the Thompson Seedless. Since all but the first crop of the Sultana contains seeds which are not removed in subsequent operations, it is in little demand as a raisin. With the abundance of the superior Thompson Seedless raisins, diversion of the Sultana to wine production appears logical.

(4) *Currant.*—This is a very small, dark, round grape that produces an excellent small raisin highly prized for bakery and confectioner use. Like its Greek counterpart, this raisin is always referred to as a currant. The California product is generally referred to as a Zante or Xanti currant.

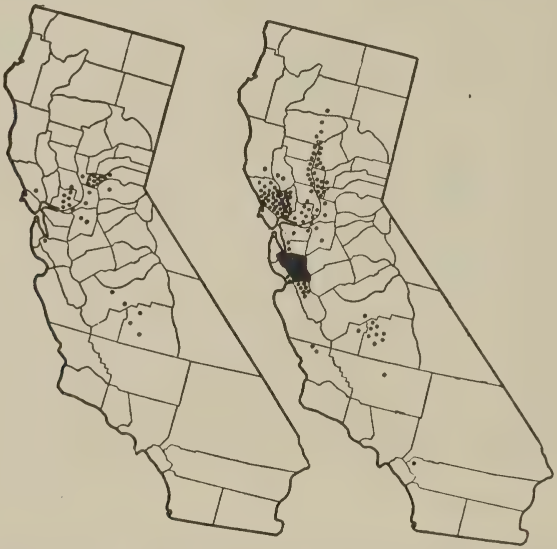

Figure 30.—Distribution of prunes and plums in California (one dot equals 1000 acres). Left, plums; right, prunes.

81. PRUNES.—*a.* The prune is a type of plum, but just as all dried grapes are not raisins, all dried plums are not prunes. The difference lies in the quality of the dried product, prunes being rich in sugar, luscious, and of a pleasing flavor and consistency. Very few plums (other than prunes) are dried. Four principal varieties are grown:

(1) *French (Prune d'Agen).*—This comprises the bulk of the California pack. Prunes sold under the trade name "Santa Clara" are of this variety

grown in the Santa Clara Valley. The trade term "Three District" refers to the French prune grown in the three principal areas: Santa Clara Valley, Sonoma Valley (Healdsburg), and the Napa Valley; the term is intended to indicate a uniform quality superior to that of any other area. The fruit has a high sugar content and dries easily and quickly. The flesh is greenish-yellow, almost translucent when dried. The skin is a glossy black. It has the smallest proportion of pit to flesh of all the prune varieties, and is the most popular variety with the American public.

(2) *Italian.*—This variety comprises the bulk of the crop in the Pacific Northwest (Oregon, Washington, Idaho). It is little grown elsewhere in the United States, but is very popular in foreign countries. Its flesh is yellow and of fine quality. It is rather tart and requires the addition of sugar when eaten. In the Northwest it is canned, dried, and shipped fresh.

(3) *Sugar.*—This variety is second in importance to the French in California. It is grown principally for sale in the fresh market. It is larger than the French; has tender, sweet flesh; and the skin is of a reddish cast. It keeps poorly in storage compared to other varieties.

(4) *Imperial (Imperial Epineuse).*—This is a popular variety in California because of its size. It produces a larger prune than any other variety. Practically all the crop is sold in the 18-24 and 20-30 prunes per pound grade, whereas the French never exceeds the 30-40 per pound grade. It has a thick black skin and is difficult to sun-dry. It sells at a premium because of its size.

(5) *Other Varieties.* The Robe de Sergeant, a small prune, and the Burton, a large one, also are grown in sufficient quantities to be segregated according to type, although they are generally blended in with other prunes. The "Silver" or Golden Drop is the only one exposed to sulfur dioxide before drying. This bleaching treatment gives it a pale silver-yellow color. It is grown principally for canning, and only small quantities are dried. It is an unsatisfactory prune because of the coarse, dry texture of the flesh. Both the prune and the pit are large.

82. FIGS.—*a.* Four varieties of figs are dried commercially in California.

(1) *Calimyrna.*—This is the famous Smyrna fig grown in California. The fruit is large, the skin is creamy amber, and the interior a dark brown. This fig is very rich and tasty. It is by far the best of all figs.

(2) *Adriatic.*—This fig is a widely grown crop of the Mediterranean countries. The skin is an amber-brown and the interior brown, fairly sweet, but not as rich and juicy as the Calimyrna. This is the most widely grown California fig.

(3) *Kadota.*—This small thick-skinned fig is grown almost entirely for

canning. The dried fig is principally a by-product of the canning industry; it has a good flavor, but is used primarily in preparing fig paste. This fig is relatively seedless.

(4) *Black Mission.*—This is the only black-skinned fig grown in Cali-

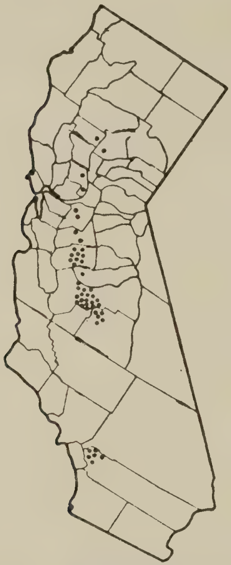

Figure 31.—Distribution of figs in California (one dot equals 1000 acres).

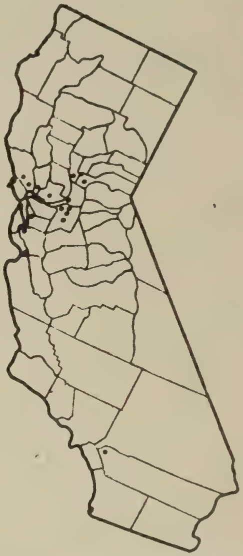

Figure 32.—Distribution of cherries in California (one dot equals 1000 acres).

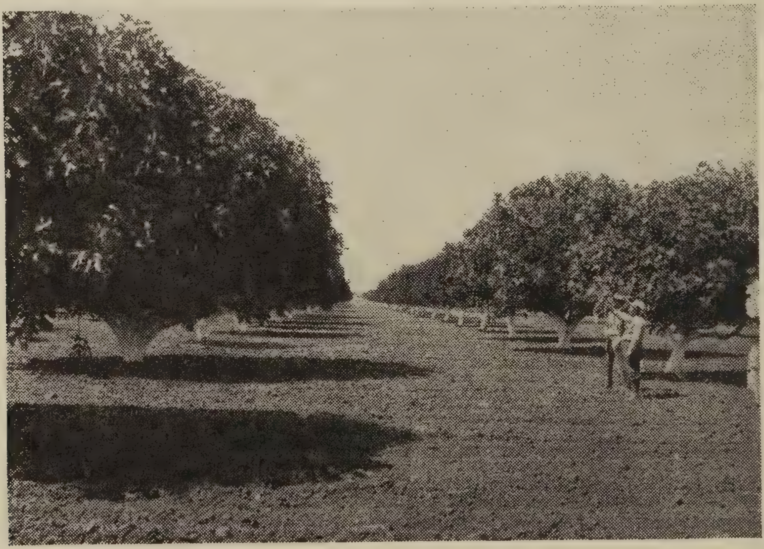

Figure 33.—Fig orchard. Note trunks white washed to repel insects.

fornia. The skin is black and thin. The meat is rich, sweet, and possesses a rather strong pleasant flavor. This fig dries to a much firmer product than the white varieties.

83. CHERRIES.—Cherries are grown primarily for use as fresh fruit, canning, or sulfiting. A small quantity of sweet cherries are sun-dried as by-products of these industries, but these are generally blemished and of poor quality. Present improved methods of dehydration offer possibilities as an accepted means of preservation, as the dehydration of sweet cherries results in a very satisfactory product. There appears to be little probability that commercial quantities of satisfactory sun-dried or dehydrated cherries will be produced.

84. DATES.—A limited quantity of dates are produced in the Coachella Valley in the extreme southern tip of California. They are frequently classified as dried fruits because of their low moisture content and general similarity to dried fruits. However, the only ripe date produced is the "dried" date, as this is the condition of the fruit at the time it is picked, at full maturity. Any additional drying to reduce the moisture content is only incidental, and is not necessarily to be considered an integral part of the production process. The date industry is relatively small and the excellent product is readily consumed through fresh fruit channels. The Deglet Noor is the principal variety. Arizona is also an important date growing state.

OTHER FRUITS

85. GENERAL.—Several other fruits have been dried satisfactorily by dehydration, either on an experimental basis or on a small commercial scale. At present their production is so limited as to merit only brief mention. They are listed here only for the sake of completeness.

86. BANANAS.—*a.* This fruit may be dried by the use of sun, spray, drum, or cabinet-drying procedures. Commercial production is maintained in several Central and South American countries. Von Loesecke has outlined the preparation and drying procedures used in the industry. Preparation consists of peeling, after which the fruit is ground, split, or sliced, depending on the drying procedure to be used. The waste amounts to 45-60 percent. Treatment with sulfur dioxide may be applied and depends on whether a light colored product is desired or not. The slurry for spray drying is prepared from fruit dipped in a 1 to 2 percent solution of sulfite before drying. Von Loesecke has outlined the following promising procedure for cabinet drying: ripe bananas are split, dipped in a 3 percent solution of sulfurous acid, spread on trays and dried at 150-160° F. The drying time is from 8-10 hours and the yield amounts to about 12 percent based on the weight of the fresh, stemmed fruit. The finished product will contain about 130 p.p.m. of sulfur dioxide.

b. Gadgil favored slicing bananas into thin slices since they dried much more readily. One-quarter inch slices dried in 6 hours, while one-half inch slices required 10 hours at 110° F. in an air blast dehydrator. He recommended sulfuring slices 30 minutes and whole bananas 1 hour in the fumes of burning sulfur. Sulfuring is desirable but must be carefully controlled, for oversulfuring will cause the banana to have a very unpleasant taste. This is particularly true if the fruit is not fully mature. The over-all drying ratio, according to Gadgil, is about 5:1, and the actual drying ratio 3:1. The finished product should not contain more than 15-18 percent moisture. Gadgil observed good keeping qualities at 15 percent moisture, while fermentation took place sometimes when the dried product contained 22 percent moisture.

87. BERRIES.—*a.* Some berries are now being dehydrated successfully on a commercial scale. The product has proved satisfactory and there is a good possibility that this may become a standard method of preservation.

(1) *Blueberries.—(a)* This fruit is not produced widely throughout the United States, but in certain areas, particularly in some of the Atlantic and Pacific States, the crop is of importance. In recent years the use of

blueberries in pies and other bakery products has reached considerable proportions. Most of the fruits used for these purposes have been canned or in the fresh state. Few, if any, were frozen and none dried.

(b) Friar and Mrak conducted a number of drying tests with only the small California huckleberry (Vaccinium ovatum) since the large blueberry (Vaccinium corymbosum) was not available. The results, therefore, apply to the small huckleberry, but are indicative of what one might expect when drying the larger berries. Berries used in the experiments were produced at Elk, California and were about a day old at the time of drying. They were washed in cold water and then dehydrated without treatment, after steam blanching, after blanching and sulfuring, and after sulfuring without blanching. Dehydration was accomplished in an air blast drier at several temperatures. The dried product was stored for 10 months at 90° F. and then checked for flavor and cooking qualities. An excellent finished product was obtained.

(c) Production of about one ton of dehydrated blueberries was made for Army experimental use in a commercial dehydrator in Maine. The product showed good keeping qualities and was excellent for use in pies, sauces, and other baking use. The concentration of food values made it superior to the canned product for these purposes.

(2) *Cranberries.—(a)* Most cranberries are grown in Michigan and New England. Von Loesecke has outlined the procedure used for drying cranberries. They may be dried by use of drum or tunnel driers. When drum driers are used the fruit is washed, graded, and then heated with a little water to about 180° F. The heated berries are then poured through a finisher to remove the skins and other solid materials. The cranberry pulp is dried on a drum drier. The temperature in the drum is well over 212° F. but that of the drying fruit is much lower because of evaporative cooling. From 2 to 3 minutes are required for drying. As the sheets of dried pulp are removed from the drum they are cooled and then passed through a flaking machine and into cans. The final moisture content should not be over 5 percent. The drying ratio is about 10:1.

(b) Some cranberries are sliced and then dried on trays in a tunnel dehydrator at about 150° F. The drying time may range from 5 to 10 hours. The dried slices are compressed into bricks or packed loosely in cans. Cranberries also are dehydrated whole using a similar procedure.

(c) Packing in a moistureproof container with an inert gas will give a storage life of at least 6 months, and possibly 12 months, providing the storage temperature is not appreciably above 80° F. for more than two months.

(3) *Loganberries and Raspberries.*—Cruess and Christie have reported that firm, ripe, freshly picked loganberries or raspberries yield dehydrated

products of excellent flavor and color with individual berries equal in size to the original fruit. Overripe fruit may lose considerable juice by dripping and may tend to form slabs. The berries are washed and spread on trays, about 1½ to 2 pounds of fruit per square foot. The fruit is dehydrated without sulfuring.

(4) *Strawberries.*—The varieties of strawberries produced in California are difficult to dehydrate because of their strong tendency to bleed. Cruess and Christie have recommended the following procedure. Stems are removed, and the fruit trayed. Preparation losses amount to about 3½ percent of the weight of the fruit. The tray load ranges from 1½ to 2 pounds per square foot of tray surface. The fruit is sulfured for one-half hour in order to obtain better color retention. In recent experiments Wiegand has found that vitamin C retention is increased by blanching and sulfuring. Dehydrated strawberries prepared as indicated above are suitable for use in preparing preserves, jams, and bakery products.

88. CITRUS FRUITS.—*a.* Cruess and Sugihara found that citrus fruit slices can be dehydrated on monel metal trays at 150° F. without pretreatment. The fruit, however, attains a darkened color.

b. Slices blanched in steam for 6 minutes prior to drying also will darken, but those sulfured for 30 minutes prior to dehydration retain an attractive bright color. Unblanched slices will dry in 3 to 3½ hours, whereas blanched samples require but 2½ to 3 hours. Drying should be continued in all instances until the slices are brittle.

c. Peels also can be dried by cutting into narrow strips and dehydrating about 2 hours at 150° F. These may be used to prepare the "golden shred" type marmalade of England. For this purpose, the peels are added to a clear or strained extract free of pulp made by boiling the dried, sliced whole fruit with water. The mixture is then cooked with sugar to give a clear jelly with the strips of peel suspended in it.

89. GUAVA.—*a.* The guava is little known or used in the United States although it is a palatable fruit, easily preserved and well adapted to use in cooked and uncooked preparations. Greater use should be made of guavas than at present because they are an excellent source of vitamin C, rich in vitamins A and B and iron, moderately rich in calcium and fair as a source of phosphorus.

b. For preservation Goldberg and Levy recommended drying at a low temperature. Unpeeled fruit was quartered, central pulp and seeds removed, and the remaining flesh blanched in 2 minutes. Thereafter, the fruit was dried at 130° F. for 10 to 12 hours and powdered. Failure to blanch before dehydration resulted in lower vitamin C content.

c. Boyes and de Villiers concluded that dried guavas and guava powders, on the other hand, lost their vitamin C potency rapidly in warm climates, though they were rich in this subtance when first prepared.

d. Dehydration experiments with California guavas have been made by Mrak. The fruit was quartered with stainless steel knives, seeded, blanched or sulfured, and then dehydrated in an air blast drier at 130° F. and at 150° F. The prepared fruit was blanched at 212° F. in a closed steam box. Sulfuring was accomplished by exposure to the fumes of burning sulfur for 20 minutes. Drying was considered sufficient when pieces of the dried fruit, cooled to room temperature, would break with a snap rather than bend under pressure. Sulfuring facilitated ascorbic acid retention.

e. Dehydrated guavas are thin, dull, and brittle. Some varieties show occasional crystals on the inner surfaces. The dried product reconstitutes well, and may be used as a cooked fruit with or without cream, or in a variety of desserts.

90. MELONS.—A limited number of experiments conducted by Friar have indicated the possibility of dehydrating Persian melons. The edible portion of the fruit was cut into one-half inch cubes, treated in various ways, and then dehydrated at 150° F. The most promising pretreatment involved submerging the cubes in a hot 40 degrees Brix glucose and sucrose syrup containing 3 percent $NaHSO_3$, and then allowing to stand for 2 hours before dehydrating at 150° F. Steam blanching helps but the cubes tend to become mushy. Untreated samples discolored, and attained an unpleasant taste and odor. After storage for 7 months at 65° F. samples treated as described above had a satisfactory odor, taste, and appearance. Reconstituting by soaking in a cold 20 degrees Brix syrup yielded a product with a pleasing taste, texture, and appearance. Cooking tended to cause the cubes to disintegrate.

91. OLIVES.—*a.* In the southern European countries dried olives are a common article of food. They are used on the table as a relish, in cooking, and between meals. Dried olives may be placed in three classes, namely, those dried in the natural state without previous salting or pickling, those partially or completely pickled with lye, water, and salt solutions before drying, and finally those that are cured in dry salt. The last named are commonly known in America as "Greek process olives" and are dried not by heat but by the action of salt.

b. In the drying of olives by the use of artificial heat, fresh untreated, lye dipped, or pickled olives are placed in a single layer on trays. Drying conditions similar to those for dehydrating prunes will yield a good product. Partial pickling (lye one-half to the pit) and complete pickling (lye complete to the pit) greatly accelerates drying. Pickling prior to drying greatly reduces the yield.

c. Partial pickling does not greatly reduce the yield. Storage of the fresh olives in brine before drying considerably increases the yield because of the absorption of salt. These olives, however, are entirely too salty in taste when dry and such treatment is not recommended.

d. The dried product should have a black color; therefore, if untreated olives are dehydrated they must be fully ripe with a jet black color when picked.

e. Untreated olives should be dried to less than 9 percent of moisture, and those partially or completely pickled to less than 12 percent. If the moisture content exceeds these levels, molding is apt to occur, particularly if the dried product is stored in closed containers.

f. Cruess and Friar gave tentative recommendations for the dehydration of unpitted olives. Dead ripe Mission or Manzanillo olives should be treated ½ to ¾ to the pit with lye; rinsed in water; soaked in 25° Salometer brine changed every 4 hours for 24 hours; and dehyrated to less than 10 percent moisture. Another recommended procedure is to dry pitted, pickled ripe Mission olives. Chopped olives dry quickly, and the dried product can be reconstituted in a little boiling water, or used directly in cookery.

g. See Volume IV for additional information on olives.

92. PERSIMMONS.—*a*. In China and Japan dried persimmons are popular, but there has been no significant demand for such a product in this country. Dried persimmons are fair in taste, but cannot be classed with such dried fruits as prunes and apricots. Immature persimmons are normally very astringent, and for this reason are allowed to become soft ripe before eating. For dehydration, however, firm ripe fruit may be used, since during drying the puckery taste disappears. Hachiya and other puckery varieties may enter the dehydrator when too puckery to eat and emerge, when dried, as sweet as the persimmon that has been allowed to become soft ripe before drying. The Fuyu, Suyukaki, and Kuro Kuma varieties give somewhat better products than the Hachiya when dried. The dried pieces maintained their form, and were superior in flavor.

b. Firm ripe fruit should be peeled, and halved or quartered with stainless steel knives. Trimming losses amount to about 30 percent of the weight of the fruit. The loss is less with firm fruit than with soft ripe fruit. The pieces spread on wood trays one layer deep should be dried without sulfuring, since the use of sulfur dioxide favors retention of the puckeryness. The fruit can be dried satisfactorily at 160° F., but there is less injury at temperatures ranging from 140-150° F. The drying time for slices is about 13 hours, and about 26 hours for quarters. The dried product is light brown to medium brown in color. After 6 months' storage the surface tends to become coated with dextrose sugar crystals, but these add rather than detract from the appearance of the fruit. The texture is fairly tender but unlike other dried fruits. The flavor is mild and pleasant but rather flat when compared wtih dried apricots. When rolled in sugar before drying the fruit has a glaceed appearance and is much sweeter.

93. PINEAPPLE.—Dehydrated pineapple has not been produced on a commercial scale because of its popularity when canned and because of its poor keeping qualities when dried. Cruess and Balog stated, however, that pineapple sulfured before dehydration retains its color and flavor very well whereas the untreated and steam blanched fruit darkens badly and attains an off-color and flavor in storage. They suggested the following procedure: peel, core, and slice thoroughly ripe pineapples with regular cannery equipment. The slices should be about ⅜-inch thick. Spread one layer deep on slat bottom wooden trays of the type used for other fruits. If sticking to the trays is serious, oil with confectioner's slab oil before use. Place trays on a dehydrator truck and put them in a tight sulfur house. Sulfur for 1½ to 2 hours. Dehydrate in tunnel drier.

94. PLUMS.—*a*. Cruess has dehydrated experimentally several varieties of plums. The Santa Rosa, Blue Diamond, Wickson, and Climas gave satisfactory dried products, with the Santa Rosa ranking first in quality. The Burbank, Kelsey, Grand Duke and Giant gave fair results, while the California Blue was very poor in quality after drying.

b. In preparing plums for drying it is desirable to dip them for about 15 seconds in a boiling ¼ to ½ percent solution of sodium carbonate. Care must be taken to avoid over-dipping which occurs very easily in certain varieties or if the fruit is firm. Exposure of the dipped fruit to the fumes of burning sulfur for about one hour greatly facilitates retention of flavor and color in the dried product.

c. When cooked, most dehydrated plums tend to retain little of their original form although the color is good. The taste is quite acid, although fruity. Cruess has pointed out that dehydrated plums would have to compete with prunes, and since the plum requires the addition of sugar and prunes do not, they would be at a considerable disadvantage. The dehydrated plums are excellent as a raw material for the making of jam, jelly, and preserves, and for use in pies.

95. POMEGRANATES.—This fruit is grown primarily for consumption in the fresh state or for conversion into juice. Pomegranates are not very suitable for use in dehydration because of their complicated structure. It is difficult to remove the arils from the hulls. Nevertheless, this can be done for drying on a small scale as follows: The fruit is halved by cut-

ting crossways with a *stainless steel* knife. One half of the fruit is then held with the cut surface about ½-inch above the palm of the hand and tapped gently with a tablespoon. The fruit should be held over a pan during this operation for the arils and some juice will drop from the hull. One hundred pounds of medium size fruit (10-12 per pound) will yield about 43 pounds of arils and juice. Arils spread on monel metal trays and dehydrated, without pretreatment, at 150° F. require about 10 hours for drying. The drying ratio of the arils is about 4:1 and the whole fruit (considering waste) about 10.5 to 1. The dried arils retain color and flavor for several months at room temperature, and when refreshed in water yield a juice possessing a good color and flavor. Sulfured arils have a less desirable taste and a bleached appearance.

SECTION IX

FRUIT NUGGETS AND POWDERS

96. GENERAL.—Fruit nuggets and powders are comparatively new products in the dried fruit field. Although nuggets and powders can be made from any dried fruit, only the apple nuggets have so far been in any demand. When reconstituted and cooked, they result in an applesauce superior in quality to that obtained by canning or cooking dried apples and almost equal to that prepared from fresh apples.

97. PRODUCTION.—*a.* The preparation procedure consists first of grinding dried apples, then spreading them on metal trays. A new innovation is the continuous compression extruder. The coarsely ground fruit is forced through a multitube vacuum lock. The arrangement of tubes serves to distribute the ground fruit evenly on two counter-rotating feeders, located at the bottom of a vacuum chamber. A vacuum of 29 inches is maintained in this chamber for a dual purpose; foremost is the elimination of entrapped air in the compressed ribbons of fruit, since under vacuum dehydration the air pockets tend to expand and destroy the ribbon structure. Of secondary importance is the fact that as the fruit emerges from the extrusion nozzles it is subjected to pressure by the atmosphere.

b. The trays of ground fruit, or compressed ribbons, are placed on heated shelves which conduct heat to the fruit. Drying takes place in a vacuum of about 28 inches at first and over 29½ inches in the later stages, and at a temperature safe to use for the particular fruit. The fruit temperature, however, is usually between 100-135° F. whereas the coil temperature may be as high as 333° F. The drying time will vary with the product being dried.

c. Predrying in a rotary or other type of drier is sometimes used to partially reduce the moisture of freshly ground dried apples prior to vacuum drying. This procedure reduces the vacuum drying time considerably.

d. Since fruit nuggets and powders are very hygroscopic, they must either be packed in moistureproof containers or stored in low humidity rooms. The relative humidity of the packing room should be below 25 percent and the temperature about 70° F. About 12 pounds of nuggets or 25 pounds of ribbons can be packed into a 5-gallon can. Fruit nuggets other than apples have not been produced on a large scale primarily because of difficulties involved in introducing new products to the trade. As time goes on it is believed they will meet trade acceptance.

e. Fruit powders made by grinding vacuum dried fruits are well adapted for institutional use in cooking and baking. They also are excellent products for use in the manufacture of prepared real fruit desserts. It is usually necessary to add an anti-caking agent to fruit powders to maintain them in a free flowing condition.

98. STORAGE.—Fruit nuggets and powders retain flavor and color in storage much better than ordinary dried fruits. It has been found that odor, flavor, and color may be preserved with very little change, provided the product is held in an atmosphere essentially free of oxygen and not subjected to a temperature over 80° F. for more than a few months. Gas packs apparently hold up best, while others develop a slight "hay-like" odor. When packed in non-moistureproof containers, the moisture uptake results in a loss in quality and a caking in the package.

99. RECONSTITUTION.—Fruit nuggets and powders will reconstitute to make sauces or jams in a matter of a few minutes. One 5-gallon can of nuggets will serve 350 people or supply filling for forty-three 9-inch pies. One pound of nuggets represents about 10 pounds of fresh apples and will reconstitute into about 8 pounds of applesauce.

QUALITY CONSIDERATIONS IN DRIED FRUITS

100. GRADING.—As has been mentioned previously, blanched dehydrated fruits are designed as a premium product, and with reasonable care in their production, they may be expected to meet the highest quality requirements for any fruit product. The standards for grading are based primarily upon the quality of the fresh fruit, with additional consideration being given to possible defects occurring through subsequent handling. Decay, insect contamination, defective fruit, pit pieces, and foreign matter are given greatest consideration. Size is considered only in the elimination of very small fruit.

a. Industry Grades.—Grades assigned by the industry traditionally have been based almost entirely upon size. Control of other types of defects is made to meet specifications and to conform to regulation promulgated under the Pure Food, Drug, and Cosmetic Act. There is ample justification for size grading, because the larger pieces of fruit are quite generally riper, tastier, more meaty, very nutritious, and more appealing to the eye. They quite naturally have a correspondingly higher market value. Industry grades, and sizes corresponding to these grades are given in tables XII, XIII, and XIV. Table XV shows the relation between prune size and percentage of pit in samples of graded unprocessed prunes.

TABLE XII

SIZE GRADES OF CUT FRUITS AND FIGS

Size Grade	Screen Size in Inches										
	Apricots			Peaches			Pears		Figs		
	Santa Clara	San Joaquin	Moorpark	Cling	Lovell	Muir and Yellow	Mendocino	Bright	Black Mission	Calimyrna	White Adriatic
Jumbo	....	....	....	Over 64/32	Over 64/32	Over 64/32	Over 60/32	....	....	....	....
Extra Fancy	44/32	Over 42/32	46/32	64/32	64/32	64/32	60/32	Over 56/32	Over 38/32	Over 44/32	Over 42/32
Fancy	40/32	42/32	44/32	58/32	58/32	56/32	56/32	56/32	38/32	44/32	42/32
Extra Choice	36/32	38/32	36/32	48/32	50/32	48/32	48/32	48/32	34/32	38/32	38/32
Choice	32/32	32/32	32/32	44/32	46/32	44/32	44/32	44/32	30/32	34/32	34/32
Standard	28/32	28/32	28/32	36/32	36/32	36/32	36/32	38/32	26/32	30/32	30/32

TABLE XIII

SIZE GRADES OF PRUNES

Size Grade (Number per pound)	Screen Size (inches)
20-30	Over 40/32
30-40	40/32
40–50	38/32
50–60	26/32
60–70	34/32
70–80	32/32
80–90	30/32
90–100	28/32
100–110	26/32
110–120	24/32

TABLE XIV

SIZE GRADES OF RAISINS

Size Grade	Raisin Variety	Screen Size (inches)
Four-Crown	Loose Muscat	Over 21/32
Three-Crown	Loose Muscat	21/32
Two-Crown	Loose Muscat	17/32
One-Crown	Loose Muscat	12/32
Large	Thompson Seedless	Over 12/32
Medium	Thompson Seedless	12/32
Small (Midget)	Thompson Seedless	19/64

TABLE XV

MEAT-PIT RATIO IN PRUNES

Nominal count	Actual count	Percent pit by weight	Percent meat by weight
30/40	31	10.9	89.1
40/50	47	11.6	88.4
50/60	56	12	88
60/70	69	13	87
70/80	81	14.6	85.4
70/80	80	15.7	84.3
80/90	85	15	85
120/up	136	22.1	77.9

b. Federal Grades.—(1) The United States Department of Agriculture, under provisions of the Federal Pure Food, Drug, and Cosmetic Act, has established certain standards of quality for dried fruits; and federal specifications, limiting the presence of defects, have been promulgated for most dried fruits. The size grades of industry have been essentially retained, but as commercial sizes rather than indications of quantity. The terms "Jumbo," "Fancy," "Extra Choice," etc., as pertaining to size have been replaced by numbers, the lower numbers indicating the larger sizes of fruit.

(2) Listed below are the principal factors affecting the quality of dried cut fruits upon which Federal tolerances have been placed:

1. Decay.
2. Slabs, scraps, broken halves.
3. Immature fruit.
4. Pit pieces, mold, imbedded dirt, insect injury, other foreign material.
5. Discoloration, sunburn, hail marks, limb rub, scab, disease, similar defects.

(3) The three principal grades (A, Fancy; B, Choice; C, Standard) differ almost solely in the allowance permitted for these defects. Grade D, Slabs, is identical with Grade C, except that it contains a greater proportion of slabs. A maximum limit is set upon the moisture content of all dried fruits.

(4) Whole fruits have a different set of defects upon which quality grades are based, as compared to cut fruits. For raisins they are stem pieces; cap stems; black, poorly developed, hard or red berries, blow-overs, and shells; "B" berries; damaged (mechanical); and visibly sugared. For prunes they are decay; mold, imbedded dirt, extraneous material; skin damage from sun or dehydration; scab; breaks; splits; growth cracks, etc., of varying degree. In figs the most serious defects are insect infestation; mold, sour, or disease; bird-pecked or dirty; worthless (meatless).

101. FOOD VALUE.—*a.* Dried and dehydrated fruits come close to preserving the desirable qualities of fresh fruit. The single aim of drying or dehydrating is the removal of water. This is not entirely possible as other changes unavoidably occur. The various treatments given to the fruits before, during, and after drying are designed to inhibit these changes to the greatest possible degree. Blanching (on this particular type of product) inactivates the enzymes which cause browning through oxidation and effects certain other changes, such as developing an appearance of translucence through removal of intercellular air. Sulfuring retains the natural fruit color, and is indispensable in maintaining the naturally high vitamin content of these fruits.

b. It is characteristic of the dried fruits of commerce that they are high in sugar and, with few exceptions, low in protein and fat. The typical dried fruit of 20 percent moisture content may be expected to contain 50 to 70 percent sugar (mostly present as invert), 3 to 6 percent acid (usually a mixture of malic, citric and tartic acids, with one predominant in a given fruit), about 5 percent ash, and small but important percentages of certain vitamins and other constituents.

c. All dried fruits are rich in minerals and are useful in establishing an alkaline reserve in the body. Figs and prunes are noted for their laxative properties. Raisins are particularly valuable for use as an added ingredient to other foods such as pastries, puddings, and cereals. All dried fruits are adaptable to use in desserts. But above all, dried fruits bring a rich fruit flavor to menus where other fruit products are not available.

102. RECONSTITUTION.—*a.* Reconstitution of dried and dehydrated fruit is a simple process. For all but a very few fruits reconstitution consists merely of rinsing, covering with water, and boiling for about twenty to thirty minutes. Experience gained in handling dried fruits suggests the exact procedures to be followed, depending upon whether the fruit is to be eaten as a sauce or used in baking. A considerably lower cooking time is required when fruits are to be used in pies, cakes, puddings, and other pastries. When desired, fruits are excellent with no reconstitution whatever.

b. Dehydrated cling peaches are the only fruit packed at normal (25 percent) moisture content which are slow to reconstitute. Blanched dehydrated cling peaches require about two hours' soaking before cooking, and dehydrated clings (not blanched) will require a full 12 to 16 hours soaking. No other dried fruits should be given an extensive or overnight water treatment as over-reconstitution will cause the absorption of abnormal quantities of water. The fruit then becomes mushy and loses its sugar to the water, making an unpalatable product.

103. FRESH AND CANNED FRUIT EQUIVALENT.—Table XVI shows the weight and number of servings to be obtained from one pound of dried fruit and the quantity of prepared food produced.

TABLE XVI

QUANTITIES OF COOKED FRUIT OBTAINED FROM ONE POUND OF DRIED FRUIT

Fruit	Weight of cooked fruit	Number of servings, with juice
Apricots	2 lbs. 2 oz.	10—⅓ cup each
Apples	5 lbs. 4 oz.	25—⅓ cup each
Figs	1 lb. 14 oz.	12—5 figs each
Peaches	2 lbs. 12 oz.	11—3 peach halves each
Pears	2 lbs. 8 oz.	9—3 pear halves each
Prunes	2 lbs. 2 oz.	11—6 prunes each
Raisins	2 lbs.	9—⅓ cup each

104. FACTORS AFFECTING QUALITY.—*a.* The maximum quality of dried fruit is fixed as it leaves the dehydrator or dry yard. From then on there is no improvement in basic quality, but every process through which the fruit passes has great potentialities for reducing the quality. The following factors are essential for the production of high quality fruit prior to drying:

(1) Careful and repeated harvesting to assure optimum maturity.

(2) Sanitation in all steps of preparation and handling.

(3) Careful cutting, dipping, or other pretreatment.

(4) Prompt action in passing fruit from one operation to the next.

(5) Adequate blanching (for blanched dehydrated fruits) at temperatures above 190° F. to assure inactivation of enzymes.

(6) Exposure to sufficient burning sulfur fumes in a tightly closed sulfur house to preserve vitamins and color.

(7) Dehydration below critical temperature with adequate and controlled air flow and humidity.

(8) Protection from contamination by dirt, insect, dust, or animals during sun-drying.

105. STORAGE.—*a.* After the fruit has been dried it is held in storage (except blanched dehydrated fruit) for from two weeks to as much as a year or more. There are four basic causes for loss of quality during storage.

(1) *Insect damage.*—This is the most serious of all as it constitutes a limiting defect in all quality grades of fruit. Insect damage can be controlled only by periodic and thorough fumigation, although low moisture content and low storage temperature tend to reduce insect activity.

(2) *Action of microorganisms.*—Microorganisms, particularly yeasts, do not affect cut fruits which are protected by their sulfur dioxide content, but they do have a serious effect upon whole fruits, and particularly upon prunes with a high moisture content in bin storage. Yeast cells can be killed by special fumigation, but the solution to this problem is to have the fruit sufficiently dry before it enters into storage. At a moisture content of 18 percent or less the fruit sugars are so concentrated that the fruit does not serve as a nutrient medium for yeast growth. Cases have been noted where as much as 10 percent of the weight of the fruit has been lost through the fermentation of fruit sugars by yeast. Quality is reduced by the decreased sugar content, and by the introduction of foreign flavors from the slow fermentation. Yeast activity apparently is associated with the sugaring of prunes, which is another factor which contributes to reduced sugar content.

(3) *Chemical action.*—Chemical deterioration of dried fruit is manifested principally by the loss of the brilliant natural fruit colors which become drab, discolored, and darkened. Sugaring of whole fruits, although associated with yeast activity, is presumably a chemical action of osmosis. Chemical reactions proceed at a higher rate as the temperature increases. Reduced temperatures are very effective in reducing these chemical changes, which stop almost entirely at about 45° F.

(4) *Mechanical damage.*—Mechanical damage is another type which results almost entirely from the practice of storing fruit in bins. A lowered quality results from the matting of fruit and the exuding of syrup caused by pressure on the lower layers of fruit. The fruit is removed from bins with a pick and shovel, and each time the pick enters the mass of fruit several pieces are damaged or destroyed. Mechanical damage can be avoided almost entirely by storage in boxes.

106. SANITATION.—*a.* Sanitation within the dried fruit industry is open to improvement in almost every process, from the harvesting of the fruit to storage after packing. It has improved materially in past years and is still improving steadily, but progress is slow. Some of the more common violations of accepted concepts of sanitation are listed here.

(1) *Predrying.*—Boxes used for harvesting fruit are frequently dirty, often being contaminated with the remains of damaged fruit from previous usage; some boxes are not washed from the time they are built until they are scrapped years later. Fruit is not always picked from trees, but may be shaken to the ground where it can become bruised and imbedded with dirt. In cutting, pits and other trimmings are sometimes dropped into the box which contains the whole fruit, with the result that the outside of the fruit is smeared with sticky fruit flesh. In sun drying on small farms facilities are rarely provided for washing fruit, trays, boxes, knives, or the workers' hands. Sanitary toilet facilities are generally not available to these cutters and handlers in rural areas. Fruit is subject to many types of contamination in dry yards. In the case of dipped fruit, adequate fresh water is rarely available for complete washing. Fruit pits and trimmings often are not properly disposed of and serve as a breeding ground for insects which may later infest the fruit.

(2) *Packing plant.*—*a.* Mention has already been made of inadequacies of storage inside the packing plant. The fruit is almost invariably exposed to the atmosphere, subject to air-borne contamination and attack by microorganisms, insects, and rodents. Many of the buildings are old and dark, with walls of wood which defy thorough cleansing by any means; although the present trend is toward modern well-lighted, easily cleaned concrete buildings. Equipment and machinery are receiving increasingly more atten-

tion, but cleansing is often inadequate, particularly with some of the older pieces of equipment. Practically all machinery is washed and steamed after use, but sterilizing chemicals are seldom used. Fortunately, dried fruit is immune to all pathological organisms so practically no health hazard is involved. If the present trend toward improvements in sanitation can be accelerated, they should eventually meet all esthetic requirements.

107. METHODS OF ANALYSIS.—*a.* Analyses for sulfur dioxide, moisture, and visual defects are routine in the production and inspection of dried fruits.

(1) *Sulfur dioxide.*—Sulfur dioxide is determined by the analytical method of Nichols and Reed. The method consists essentially of placing a 32-gram sample of ground fruit into a flask in the presence of water and acid. The sulfur dioxide is driven off by distillation and received in a flask with a measured amount of tenth-normal iodine solution. Upon completion of the distillation the excess iodine is titrated with tenth-normal thiosulfate solution and the amount of sulfur dioxide is determined by simple calculations.

(2) *Moisture.—(a)* The specified method of moisture determination is that of the Association of Official Agricultural Chemists, which is essentially the drying of a weighed sample in a vacuum oven at 70° C. for sixteen hours, reweighing, and calculating the loss in weight as moisture.

(b) However, for all routine and control purposes analyses are made with the Fisher Electric Moisture Tester. A ground sample is placed in a cylindrical bakelite tube between two electrodes and the conductivity measured by adjusting a dial. The temperature is noted and the moisture determined from a chart in which the dial reading is listed under the temperature, opposite the moisture content. The entire analysis takes only a few minutes and is sufficiently accurate for control purposes.

(3) *Visual inspection.*—Inspection for visual defects is made in accordance with procedures established by the United States Department of Agriculture. A representative sample of the fruit under consideration is taken and weighed. Each piece is carefully examined, using a magnifying glass if necessary for each of the possible defects. Defective fruit is segregated into each of the specified classifications and weighed, and the percentage of defects calculated.

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* Much of the literature cited was not directly used in the preparation of this bulletin. These added citations should serve as an aid to those who are further interested in specific questions on dried fruit.

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PART II

FRESH AND DEHYDRATED VEGETABLES

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CHAPTER ONE

FRESH VEGETABLES

SECTION I

INTRODUCTION

1. VALUE OF VEGETABLES.—Fresh vegetables are valuable in the human diet. They are excellent sources of vitamins; they contain valuable minerals, being especially rich in calcium and iron; they furnish roughage and bulk so necessary to a well-balanced diet; and since their ultimate reaction in the human body is generally alkaline, they help maintain the alkaline balance of the blood.

2. CHARACTERISTICS.—*a. Living plants.*—Vegetables are living, breathing plants, which begin to lose their vitality and food value when the life process is interrupted (as by harvesting) and rapidly diminish in food value and palatability when improperly handled or stored.

b. Ripening process.—The process of ripening in most vegetables involves numerous chemical as well as physical changes. The removal of the vegetables from the parent plants does not stop the chemical changes, but often accelerates them. Therefore, the handling of fresh vegetables in transit and in storage must be under conditions that, to a certain extent, control the ripening process. As long as vegetables remain alive, they resist deterioration from decay, but when life ceases to exist, they decay very rapidly. Their life processes consist mainly in ripening and breathing. The ripening process is constructive, while the breathing process is destructive.

c. Breathing process.—The breathing process involves the consumption of oxygen, the oxidation of the substances of the cells, such as starch, sugar, fat, and proteins, and the liberation of carbon dioxide gas, water, and energy. Most of the energy is manifested as heat. The rate of both the ripening and the breathing process is greatly influenced by temperature, being accelerated by a high temperature and decelerated by a low temperature.

3. PRECAUTIONS.—*a.* Since the respiration process requires oxygen and liberates carbon dioxide gas, proper ventilation is essential to continued life. In the transportation and storage of fresh vegetables, the external conditions of ventilation and temperature must be kept within a narrow range if these products are to reach the consumer in good condition.

b. Thus it can be seen that in order to be of good quality, vegetables must not be bruised or broken, or allowed to wilt or lose an excessive amount of moisture; they must have their respiration and ripening retarded by refrigeration; and, they must have sufficient ventilation to provide them with oxygen and carry off the carbon dioxide.

4. EFFECT OF COOKING.—Vegetables are cooked to make them more easily digestible, or more palatable. The method of cooking them usually has a decided effect upon their color, odor, and nutritive value. In some vegetables one method of cooking may preserve all these qualities, in others it may be necessary to sacrifice one or two in order to preserve the third, but it is never necessary to sacrifice all four as is frequently the case.

5. MAINTENANCE OF COLOR.—Vegetables naturally fall into four groups of color—green, yellow, red, and creamy white. Each is the result of distinct chemical compounds and different in its properties from the others. No general rules of cooking cover them all.

a. Green.—Chlorophyll, the coloring pigment of green vegetables, is almost insoluble in cold water. It is easily destroyed by heat or by acid, which usually comes from the vegetable itself. When vegetables are cooked for a long time in a small amount of water or steam in a covered vessel or under pressure, the chlorophyll is decomposed. If green vegetables are placed in a plentiful supply of boiling water the green color is intensified because the chlorophyll is released from the plastids (tiny compartments) and moves to the surface, where it is temporarily held in place by coagulated protein. The general rule for the preservation of green color in vegetables is to drop them into an abundance of rapidly boiling water and cook them uncovered for the shortest possible length of time.

b. Yellow.—Yellow color found in carrots, squashes, and sweet potatoes comes from a class of pigments called "carotinoids" which are always associated with the chlorophyll in green vegetables, but remain invisible until the chlorophyll is dissipated. Thus, the green leaves turn yellow in the fall of the year. When green vegetables are cooked in an improper manner the chlorophyll is dissipated; and the little which remains, together with the yellow pigment gives them a greenish-bronze appearance. Since the yellow pigment is very stable, vegetables which have only this color can be cooked in any manner without change in color. When yellow vegetables turn dark brown, the reason is usually oxidation, or scorching, or caramelization of the sugar content.

c. Red.—Red color, though somewhat rare, is found in beets, tomatoes, red cabbage, and radishes. It remains red in the presence of acid, but turns to violet or purple when alkali is predominant. The method of preserving red in vegetables is exactly the opposite of that used for green, because the water must be acid. Tomatoes and unpeeled beets can be cooked without added acid and still retain their color because they have sufficient acid content.

d. White.—Most white vegetables contain pigments called flavones, which seem to be fairly stable in heat. Certain white vegetables have a disagreeable and as yet unexplained color change to a brownish-gray. This is due chiefly to long cooking. It is thought that the flavones may unite with the iron in the vegetables and thus form a dark compound, or that the flavones may in some manner be changed to the anthocyanins in one of their unpleasant forms. It is also possible that in certain vegetables the sulfur and iron combine to form a dark compound. Whatever the cause, it is certain that the darkening takes place only when a long time is consumed in the cooking. It therefore follows that this discoloration can be avoided by cooking vegetables only enough to make them tender.

6. RETENTION OF FLAVOR.—So far as cooking for the retention of flavor is concerned, vegetables divide themselves into three classes: the cabbage family, which also includes brussels sprouts, cauliflower, and turnips; the onion family, including garlic, shallots, and chives; all other vegetables.

a. Cabbage family.—The vegetables of the cabbage family contain sulfur compounds which break up easily under certain conditions and produce substances disagreeable to the senses of taste and smell, one of them being hydrogen sulfide. Decomposition of the sulfur compounds is brought about by long cooking or by cooking at low temperatures; both should be avoided. Pressure cooking is the least satisfactory, as all volatile acids evolved from the vegetables are retained. Such vegetables should be cooked in the shortest possible time in an uncovered vessel and in a large amount of boiling water.

b. Onion family.—Vegetables of the onion family obtain their strength from certain volatile and aromatic substances formed in the growing stage. Unlike the cabbage family, they do not form new odors or flavors in cooking but simply lose part of those present. When heat is applied the volatile substances begin to dissipate with the steam. The properties which provide a pleasing flavor do not always provide a pleasing odor. The lingering odor of boiled onions is seldom considered pleasant. With long cooking the flavor is entirely volatilized and the onions are insipid and flat. By cooking in a steamer or pressure cooker the greatest amount of flavor is retained in them. Most people desire a happy medium between these two forms of cooking.

c. Other vegetables.—All other vegetables lose flavor when cooked in a large amount of water; hence, they should be cooked in a small amount of water, or in a steam or pressure cooker. They should be cooked as fast as possible and never overcooked.

7. METHODS OF COOKING. — The three principal methods of cooking vegetables are baking, steaming, and boiling. These will be considered solely from the standpoint of nutrient saving.

a. Baking.—Baking means cooking in dry heat in an oven with the addition of little or no water. In this method of cooking the nutritive losses are small, the chief loss being of vitamin C. Dry baking is usually limited to potatoes and squashes.

b. Steaming.—The most satisfactory method of cooking vegetables to preserve their nutritive value is by steaming. It can be done either in a vessel where the temperature never exceeds that of boiling or in a pressure cooker where 249° F. can be attained. It is done without the addition of water to the vegetables except in a small quantity necessary for the steam. The special advantage of this method is that the only water that comes in contact with the vegetable is the small quantity formed by condensation. It is recommended that all vegetables that can be steamed without loss of color or flavor be steamed. Such vegetables are Irish and sweet potatoes, carrots, string beans, parsnips, spinach, beets, and tender greens.

c. Boiling.—More nutrients are lost by boiling vegetables than by any other method of cooking. Some part of the minerals and other nutrients which have escaped into the boiling water can be recaptured by using the water in which the vegetables are boiled for soup and this should be done as far as possible. Boiling should be used for cabbage, turnips, and onions.

d. Conclusion.—Vegetables should be cooked only until tender. More vegetables are ruined by overcooking than by undercooking whether by use of the cafeteria steam tables or the kitchen range. Hence, in addition to describing the various fresh vegetables, much of this text will be devoted to the proper cooking and handling of them.

FRESH VEGETABLES

8. ARTICHOKES.—The artichoke is a highly prized vegetable in European countries but has not become popular in the United States. The United States crop is grown mainly in California.

a. Varieties.—Two kinds of artichokes are grown as a food crop: the French or Globe artichoke and the so-called Jerusalem artichoke.

(1) The French or Globe artichoke is a member of the thistle family. Globe artichokes come mostly from the coastal counties of California. Those of best quality are plump, fleshy, and tightly folded. The edible portion is actually an immature flower bud and only the tender portions of each scale are eaten. There are several varieties, which differ in size and shape of the bud, some producing a conical bud and others a globular bud. In general, the Green Globe variety is most widely produced.

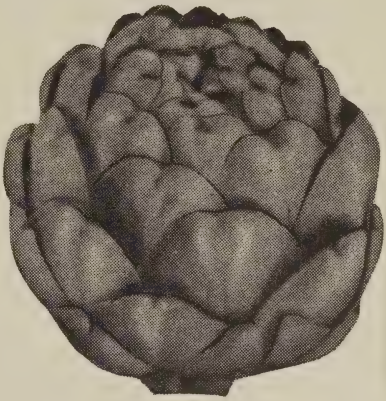


Figure 1.—Artichoke.

(2) The Jerusalem artichoke, although an entirely different type of plant from the Globe, resembles it in flavor. Often called the poor man's potato, it may be compared to the white potato since the root, or tuber, is the edible part. The varieties differ in the color and size of the tubers. There are white-, purple-, red-, and yellow-skinned varieties but the flavor is not materially different.

b. Harvesting and marketing.—Globe artichokes are harvested in the spring before they become loose and fibrous. The buds are separated into five or six sizes and packed in paper-lined boxes in either of three sizes: large, 9¾ by 11 by 20⅝ inches; half-sized, 4⅞ by 11 by 20⅝ inches; and a size used for local shipments, 8½ by 14 by 22⅜ inches. The large- and half-sized boxes are used for long-distance shipment. From 4 to 10 dozen buds can be packed in a box. Artichokes stored at 30° F. will keep in good condition from 30 to 60 days (see par. 43).

c. Inspection and quality.—(1) Artichokes for Army procurement shall be U. S. No. 1 grade and shall meet the requirements specified in the U. S. Standards for Grades for Artichokes.

(2) Compact, heavy, globular, plump French Globe artichokes, which yield slightly to pressure and have large, tightly clinging, fleshy leaf scales

of a good green color, are the most desirable. Freshness is indicated by the green color, which becomes brownish with age or injury.

(3) Overmaturity is indicated when the artichokes are open or spreading; the center may be fuzzy and of a dark-pink or purple color; the tips of the scales are hard. When they are cooked the flavor is strong and the scales are tough and woody.

(4) Discolored artichokes are generally old or stale or may have been bruised. Bruises appear as dark-colored areas at the point of injury, and may be covered with mold. Discolored artichokes turn black when cooked. Worm injury occurs mainly at the base of the bud. It may appear very small from the outside but extends deeply into the heart. Artichokes affected by any of these injuries are not desirable unless they can be trimmed without undue waste.

d. Suggestions for use.—On account of their excessive cost, artichokes are not used extensively in the average mess. However, if grown locally and purchasable at a reasonable price they may be used to add variety to the mess. They may be served in salads or cooked in salt water and served hot with hollandaise sauce or drawn butter.

9. ASPARAGUS.—Asparagus is one of the most valuable of the early vegetables and perhaps the most important of the perennial vegetable crops. The production of asparagus from March to July is widespread but is most concentrated in California, New Jersey, South Carolina, Georgia, Illinois, Maryland, and Washington. About one-half of the total asparagus grown for the fresh market is produced in California from March to July and from October to November.

a. Varieties—(1) There are only a few varieties of asparagus, the more popular being Mary Washington and Martha Washington. These varieties are resistant to asparagus rust and have an excellent flavor. Other varieties are Palmetto, Reading Grant, Argentenil, Conover Colossal, and Mammoth White.

(2) Three kinds of asparagus, classified according to the color of the spears, are marketed. The spears may be entirely green, green with white butts, or entirely white. The greatest market demand is for a green asparagus, whereas most of that grown for canning is white.

(a) Nearly all the green asparagus is harvested with a small amount of white on the butt end. The entirely green asparagus that is cut at the surface of the ground does not keep as well as that cut with a part of the underground shoot. Since the part of the stem that was underground is more woody than that above ground, it loses moisture less rapidly than the tender green part and adds to the keeping quality of the spears.

(b) White asparagus is obtained by growing the spears in darkness.

This is done by ridging the soil over the crowns and cutting the shoots below the surface as soon as the tips of the spears appear. On account of the early cutting of the shoots, white asparagus is grown in some localities where the asparagus beetle is prevalent, in order to reduce the loss from beetle injury. The injury done by the beetle causes the spears to grow crooked and otherwise mars their appearance, which impairs their market value.

b. Harvesting and marketing.—(1) Asparagus shoots grow very rapidly, especially if the temperature is high. If not harvested at a fairly young stage, they become tough and fibrous, and the tips become spread or even seedy.

(2) The cutting should be done with a knife having a V-shaped blade made especially for the purpose. Green asparagus should be 9 to 10 inches in length, and at least half of the length should be above ground. As the lower end is fibrous and less palatable, the underground part should not be too long.

(3) In preparation for market, asparagus stalks are carefully graded, trimmed, and tied in bunches weighing from 2 to 2½ pounds. Sometimes the poorer grade and field-run asparagus are packed in crates without grading or bunching. In some localities, the Kennewick district of Washington in particular, some first-grade asparagus is shipped loose in crates without bunching. In some sections of the East and Midwest, asparagus is packed in 1-pound bunches, as some markets prefer the small bunch; or the large bunches are divided into smaller ones by the retailer.

(4) The crate most commonly used in shipping asparagus is pyramidal in form and has two compartments each holding six 2 to 2½ pound bunches. It is 11 inches deep, 9 inches wide at the top, 11 inches wide at the bottom, and 18 inches long. It is a very satisfactory shipping container, as the pyramidal shape conforms to the taper of the bunches and prevents their being shifted about in shipment.

(5) Asparagus loses its edible quality very rapidly after it is harvested, owing to chemical changes in the spears which reduce the amount of sugar and increase the amount of tough fibrous material. Analyses of the spears at various intervals after cutting show that the reduction in sugar content and increase in fiber take place most rapidly during the first 24 hours after harvesting. This is particularly true in white asparagus. Although deterioration goes on at all temperatures, it is much slower at temperatures near the freezing point. Because of this rapid loss in quality at high temperatures, asparagus must be brought in from the field, bunched, packed, and placed in a cool atmosphere as soon as possible after it is cut. It is good practice

to protect the spears from the sun as much as possible when they are harvested during very warm weather.

(6) If the bunches are placed upright in damp moss in crates and stored at 31°-32° F. immediately after harvesting, they will keep for 3 to 4 weeks without serious loss in quality (see par. 44). The tips should be kept dry.

c. Grading and inspection.—(1) Asparagus may be graded as very small, small, medium, or large, depending upon the diameter of the spears.

TABLE I

GRADING AND DIAMETER OF ASPARAGUS SPEARS

Size	Diameter of spear
Very small	Less than ¼ inch
Small	¼ to $\frac{9}{16}$ inch
Medium	$\frac{9}{16}$ to ¾ inch
Large	More than ¾ inch

These measurements must be taken at a point not more than 8½ inches from the tip. The grading according to the diameter of the spears depends upon the market demand and the quality of the asparagus. California shippers sometimes pack as many as five grades, based on size. Eastern growers usually do not pack more than two or three grades. After trimming, the bunches should be from 8 to 10 inches long.

(2) Asparagus may be classified as green if 90 percent of the spears in any lot are of a green color, covering not less than 4½ inches of the length of the stalk.

(3) Asparagus spears should be fresh, tender, and firm, with close, compact tips. The spears for army procurment should be of U. S. No. 1 grade and should conform with the requirements of the U. S. Standard for Grades for Asparagus.

d. Diseases and defects.—(1) *Asparagus rust.*—Asparagus is subject to a number of diseases, of which only one, asparagus rust, is of much economic importance. The disease is first observed as small reddish-yellow spots on the main stems near the ground and on the very slender branches of the stalks which grow up after the cutting season is over. The damage caused by the rust organism is not seen directly in the marketed asparagus; it develops after the cutting season, and reduces the succeeding crop by weakening or killing plants. The most satisfactory way to control rust is to plant varieties known to be resistant to it.

(2) *Rots.*—Asparagus may also be affected by bacterial soft rot, fusarium rot, gray mold rot, and watery soft rot. Bacterial soft rot and fusarium rot are the most common causes of loss in marketing, transit, or storage.

(a) Bacterial soft rot is the only decay of asparagus that has an odor. Like that of many other vegetables affected with bacterial soft rot, the odor is barely noticeable in the very early stages of decay, but in the advanced stages it becomes very noticeable. It most frequently affects the tips and cut ends of the spears. The bacteria responsible for this decay become destructive during warm storage and at points where breaks in the tissue occur. This disease may be controlled or retarded by careful handling and cool storage.

(b) Fusarium rot or wilt attacks the tips or other parts of tender asparagus spears, appearing as a white, fluffy mold, which may later turn pink. The affected tips may become completely covered with mold, and the tissues converted into a soft water mass. No odor accompanies this decay unless bacteria are also present.

(3) *Asparagus beetle.*—The asparagus beetle causes much damage to asparagus by feeding on the spear and reducing its market value.

e. Suggestions for use.—Asparagus may be cooked and served with drawn butter, or as a cold salad, or prepared as a soup. It is best cooked by placing it in boiling water. If the tips are not removed, it should be tied in bunches and placed upright with the tips protruding 1 inch out of the water and cooked in this position until the butts begin to be tender. The entire spear is then immersed and cooked 5 to 10 minutes or until tender.

10. BEANS (FAVA).—Fava beans, known to some as the English or Windsor broad beans, are practically a newcomer to the American market. Although they are of no commercial importance in the United States, they are grown to some extent in California and some sections of the South.

a. Varieties.—The principal variety now grown in Europe and America for human food is the Windsor bean.

b. Marketing.—Shelled Fava beans are generally marketed in quart baskets. The green pods are marketed in hampers containing from 24 to 40 quarts.

c. Inspection and quality.—(1) The pods of the best unshelled Fava beans should be well filled, clean, bright, fresh, and of dark-green color. Dried, shriveled, spotted, yellowed, or flabby pods of unshelled Fava beans may be old or affected by disease. Beans contained in such pods are usually of poor quality; they may be tough and of poor flavor. Decay in the form of irregular sunken areas, may appear on the pods.

(2) The shelled Fava beans should be plump, with a tender skin of good green or greenish-white color. They are very perishable. They heat quickly and if kept under ordinary conditions soon become moldy or slimy.

d. Suggestions for use.—Fava beans are not common on the market and are difficult to procure except in the locality where grown. They may be served as a green vegetable or in salads. The shelled beans may be used in the same manner as lima beans.

11. BEANS, GREEN OR SNAP.—Snap beans, or green wax beans, as they are sometimes called, are grown for their immature edible-pods.

a. Varieties.—There are many varieties of both the green and the wax (or yellow-pod) beans. Some are flat; others are round. Personal preference is the deciding factor as to the color or shape to be purchased. Some varieties soon become stringy; others are stringless until nearly ripe. The stringless are rapidly replacing the stringy for commercial shipment. Green-pod bush bean varieties are Black Valentine, Bountiful, Plentiful, Stringless Green-Pod, and Tendergreen. Yellow-pod bush bean varieties are Stringless Wax and Yellow Bountiful. Pole green-pod varieties are Kentucky Wonder and Rust-Resistant. Pole yellow-pod varieties are Golden Cluster Wax and Kentucky Wonder Wax.

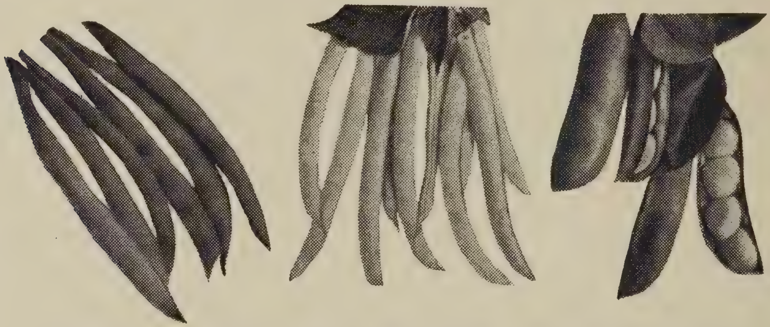


Figure 2.—Left to right, green stringless beans, wax beans, lima beans.

b. Marketing and Quality.—Most snap beans are shipped in hampers, the 32-quart hamper being the most commonly used; however, some are shipped in round-stave or tub baskets. Snap beans of good quality are clean, fresh in appearance, firm, crisp, tender, and free from blemish. All in a lot should be in the same stage of maturity. The pods in which seeds are very immature are most desirable; if the seeds are half grown or larger, the pods are likely to be tough, woody, and stringy. Beans that have a dull wilted appearance are unsatisfactory.

c. Diseases.—The prevalence of diseases of beans depends more or less on weather conditions. Moist, foggy, or rainy weather brings anthracnose and bean rust.

(1) *Anthracnose* causes a spotting of the pods and renders them unsightly and unsalable. It often penetrates the pods and causes a spotting on the seeds. On the pods its first symptoms are minute, oval or circular,

greenish-brown specks which become brick- or rust-red to black around the border as they enlarge. Precooling and good refrigeration for about 2 weeks will check the development of the infection already present.

(2) *Bacterial blight* is another common and destructive disease of snap beans. It severely spots the pods and under favorable conditions quickly makes the beans inedible. On the pods it is indicated by small watery spots that gradually enlarge and form blotches varying in color from amber yellow to almost brick red.

d. Suggestions for use.—Snap beans should be boiled in an open kettle about 15 minutes, or until tender. They can be prepared in several ways; for example, they may be served with butter, with cream sauce, with bacon cubes, or in cold salads.

12. BEANS, LIMA (FRESH).—*a. Varieties.*—Lima beans may be divided into two general classes: the large butter-bean type and the small potato type or baby lima. The large lima beans are grown to some extent throughout the United States. The baby limas are generally grown in New Jersey, Florida, North Carolina, South Carolina, Georgia, Maryland, Virginia and the Middle Western States. Their seeds are small, white, brown, or mottled, and grown in little pods containing two or three beans each. The more popular lima bean varieties having large seeds are the Fordhook, Burpee's Improved, and Burpee's Bush. These varieties have three or four white seeds in a pod. Common small-seeded varieties are the Baby Fordhook, Baby Green-seed, and the Henderson Bush. A very satisfactory new variety possessing excellent flavor, color, and quality is the Baby Potato. In the Southern States the Carolina, or Sieva, is an especially popular small-seeded variety.

b. Inspection and quality.—Most fresh beans are marketed unshelled because fresh shelled beans are very perishable. They heat quickly and if kept under ordinary conditions soon become moldy and slimy.

(1) The pods of the best unshelled lima beans should be well filled, bright, fresh, and of a dark-green color.

(2) Shelled lima beans should be plump, with tender skins green to greenish-white in color. They should be examined closely for insect injury, and tested for tenderness by puncturing the skin. Those with hard, tough skins are overmature and usually lack flavor.

(3) Unshelled lima beans stored at 32° F. may be held for 2 or 3 weeks. Shelled limas may be held for 1 week at that temperature. (See par. 46.)

c. Diseases.—(1) *Downy mildew.*—Downy mildew is a fungus disease that causes considerable damage, the fungus being most often observed on the pod. It takes the form of white, wooly masses which appear on one part of the pod and then spread to all parts. A severely affected pod wilts and shrivels.

(2) *Pod blight.*—Pod blight affects both pod and seed. In the early stages its lesions consist of circular or oval spots of darkened tissues; later they become studded with minute, gray elevations that soon break the skin of the pod.

d. Suggestions for use.—Lima beans are best prepared by being dropped into boiling salted water and cooked until tender. If served hot as a vegetable, they may be drained and sauteed in butter. In combination with other vegetables they may be served as a cold salad with mayonnaise dressing. (Except at certain seasons of the year when local-grown lima beans are plentiful, the purchase of fresh lima beans for troop mess is not feasible because of their very high price.)

13. BEETS.—*a. Varieties.*—Beets are commonly classified as two types, depending on their period of maturity; the early-crop beets, and the late-crop beets. Three of the best of the early varieties of beets are the Extra Early Egyptian, Early Wonder, and Crosby Egyptian. The Detroit Dark Red and the Crimson Globe are popular late varieties; they are generally used for canning, because of their deep-red color.

b. Harvesting and marketing.—(1) Early beets are regarded as mature when they are 1½ to 2½ inches in diameter. In warm, dry weather they may become woody if allowed to grow much larger.

(2) Early beets are usually marketed in bunches, three to five in the bunch, with the tops attached either full size or cut back to 6 or 8 inches in length. Occasionally small quantities of early beets are shipped loose to local markets; in such cases, the tops are cut back to within an inch or two of the beet.

(3) Late-crop beets are usually marketed with the tops removed. These beets are suitable for storage; those that have not been washed are likely to keep well if storage conditions are good. Medium-sized beets of the late crop are less likely to be tough or woody than the large or very small ones are.

(4) Bunched beets are shipped in either the western crate 13 by 18 by 21⅝ inches, or the half-crate 9 by 13 by 21⅝ inches. Topped beets are usually marketed in 50- or 100-pound bags or bushel baskets. Crates are sometimes used measuring 14 by 11 by 22 inches and holding approximately $1\frac{9}{16}$ bushels.

c. Inspection.—(1) Beets of good quality should be smooth and free from blemish. Beets that are rough and ridged or have deep-growth cracks are wasteful and may be tough and woody. Soft, flabby, or shriveled beets are usually poor in flavor. Examination may reveal decay, which generally appears as a form of soft rot.

(2) Bunched beets that have remained too long in the field and become tough or woody can often be recognized by a short neck covered with deep scars, or by several circles of leaf scars around the top. Fresh condition of the leaves alone should not be considered as an indication of the quality of the beets. The leaves may be badly wilted or otherwise damaged, while the roots may be of excellent quality.

d. Suggestions for use.—Beets may be steamed or cooked in a pressure cooker, as well as in an ordinary kettle, without loss of color, so long as they are not pared or cut. They may be served buttered, pickled, or in a salad or as Harvard Beets. They may also be baked. Fresh beets may be more economical at times than canned beets, but there is little, if any, difference in quality. In the early spring the tender leaves may be cooked and served like spinach.

14. BROCCOLI.—Broccoli is a variety of cabbage, hardier and with a taller stem than the cauliflower, which it otherwise resembles.

a. Varieties.—There are two varieties of broccoli: the Italian green sprouting broccoli and the heading broccoli.

(1) The Italian sprouting broccoli has undeveloped flower buds and thick, succulent stems which are the most desirable and commonly marketed parts of the plant. These bud clusters vary in size from less than 1 inch to 5 inches or more in diameter, the larger ones being called heads and the smaller ones shoots. The Glory of Calabria and Christmas Calabrese are among the best varieties.

(2) The heading broccoli is so similar in appearance to cauliflower that it is sometimes marketed as cauliflower. Early Large White French, St. Valentine, and North Star are among the best varieties.

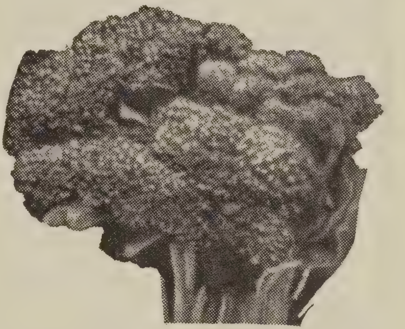


Figure 3.—Broccoli.

b. Harvesting and marketing.—(1) Italian sprouting broccoli to be of good quality should be fresh, clean, and not overmature. The stalks should be tender and firm; the buds in the cluster or head should be compact and should not have reached the stage of development at which the color of the flower is evident. The general color should be either darkish-green or purplish-green, depending on the variety. Since the whole stalk—stem, leaves, and flower clusters—is eaten, tenderness is an essential element of quality. Toughness and woodiness develop with age, and usually the toughest part is at the base of the stalk.

(2) Sprouting broccoli is shipped either loose or bunched. The large heads are usually packed in crates similar to cauliflower crates.

c. Inspection.—Sprouting broccoli that shows yellow or damaged leaves should be carefully examined and tested for tenderness. Overmature sprouting broccoli is usually woody, tough, or stringy. Overmaturity is indicated by the bud clusters or heads, which are open to the extent that the full yellow or purple color of the blossom is distinct; frequently the blossom is fully developed. An occasional open blossom does not indicate overmaturity. Wilted, flabby broccoli should be avoided as it may prove to be very unsatisfactory. Precautions should be taken against green cabbage worms and gray plant lice hidden in base of bud clusters.

d. Suggestions for use.—Broccoli may be cooked in an open kettle in boiling salted water or steamed. It may be served with butter dressing or sauce.

15. BRUSSELS SPROUTS.—*a. Varieties.*—Brussels sprouts are small, green heads, resembling diminutive cabbages that develop in the lower axils of the stem of a plant related to the cabbage. Long Island, New York, and Half Moon Bay, California, are the principal centers of production in the United States. The Half Dwarf Improved and Long Island Improved are the most important varieties.

b. Quality and marketing.—(1) Brussels sprouts of good quality are hard and firm, compact, fresh, of bright appearance and good green color. Puffy sprouts, although edible, are usually of poor quality and flavor. Those that are wilted or have yellowed leaves are usually aged or stale and should not be used.

(2) Worm injury, which is indicated by riddled leaves, causes much waste. A smudgy, dirty appearance may indicate the presence of lice, which sometimes make the sprouts unfit for food. Evidence of the presence of worms or lice may be found on the inner surface of the leaves.

(3) Sprouts are shipped from California in drums holding 28 quarts and 64 quarts, and in artichoke boxes measuring 9¾ by 11 by 20⅝ inches. Long Island and other sections of the East use pint and quart berry boxes and crates.

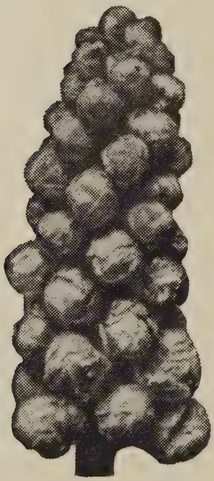


Figure 4.—Brussels Sprouts.

c. Diseases.—Brussels sprouts are subject to many of the diseases of cabbage (see par. 16*d.*), the most destructive ones being alternaria leaf spot and bacterial soft rot.

(1) *Alternaria leaf spot.*—The first symptom of alternaria leaf spot is the appearance of small, grayish-brown-to-black spots. As the spots enlarge they lose some of their circular shape and become sunken. High humidity favors the spread and development of the disease. Low temperature and low humidity greatly check the development of decay.

(2) *Bacterial soft rot.*—Bacterial soft rot produces a soft, mushy, sticky decay and a very offensive odor. It may be spread in storage by contact or by the oozing or dripping of the decayed tissues. Low temperature storage is the most important factor in the control of this disease.

d. Suggestions for use.—Brussels sprouts may be boiled or sauteed. To retain the green color they should be dropped in boiling water and cooked in an open kettle until tender.

16. CABBAGE.—Cabbage is one of the most important vegetable crops of this country. It is produced commercially in 30 States, with New York, Texas, and Wisconsin producing nearly half of the total crop.

a. Varieties.—(1) From the commercial standpoint cabbage is classed as fall, early, second early, intermediate, and late (fall or winter), according to the period in which it moves to market. The localities and seasons of production are given in table II.

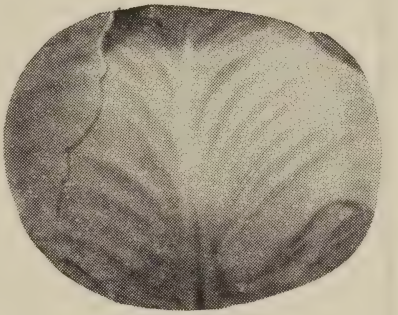


Figure 5.—Copenhagen cabbage.

TABLE II

CABBAGE VARIETIES AND LOCALITIES IN WHICH PRODUCED

Variety	Locality	Season of production
Early	California, Florida, Louisiana, Texas	December to May
Second early	Mississippi, South Carolina, Virginia, Alabama	April to June
Intermediate	North Carolina, New Jersey, Maryland, Illinois, New York, Ohio, Tennessee, Virginia	June to July
Late (fall or winter)	New York, Wisconsin, Pennsylvania, Virginia, Colorado, South Carolina	September to March

(2) Cabbage is also classified according to type: Danish, domestic, pointed, Savoy, and red. These are trade terms and have no connection with the horticultural varieties. The first three types are the most important commercially.

(a) The Danish-type cabbage is a late-maturing cabbage used for storage and marketing during the fall and winter months. The heads are normally smooth and round, very hard, and compact. Danish Ballhead and Wisconsin Hollander are the two leading varieties of the Danish type.

(b) Domestic-type cabbage is produced largely as early or midseason cabbage. The heads are less compact, and the leaf tissues are more tender and brittle than in heads of the Danish type. This cabbage does not keep well and is seldom stored except for short periods in the early fall months. There are both round- and flat-headed varieties. Copenhagen Market and Glory of Enkhuizen are the two leading round-headed varieties. Flat Dutch, Succession, and All Seasons are the principal flat-headed varieties.

(c) Pointed-type cabbage is the familiar early cabbage and includes the varieties that normally develop conical heads. The leading varieties are the Early Jersey Wakefield, Charleston Wakefield, and Winningstadt.

(d) Savoy-type cabbage can be readily identified from the unusual crinkling of the leaf tissues throughout leaves and head. The heads are ordinarily loosely formed, usually flattened; are of yellowish-green color and less odorous when cooking. The principal varieties are Drumhead, American, and Chieftain.

(e) Red-type cabbage is easily distinguished from all other types by its red or purple color. Mammoth Red Rock and Danish Stonehead are the two popular varieties.

(3) Cabbage is also graded into size as small, medium, or large, depending on weight.

TABLE III

CABBAGE SIZES

Type	Small (pounds)	Medium (pounds)	Large (pounds)
Pointed	Less than 1½	1½ to 3	More than 3
Domestic	Less than 2	2 to 5	More than 5
Danish	Less than 3	3 to 6	More than 6

b. Marketing.—(1) If a market is near by, it is advisable to purchase cabbage weekly, but if storage space is available and a market not easily accessible a month's supply may be purchased. In storing, care must be taken not to use damp storehouses; and the stock should be gone over weekly to remove any slimy leaves or decayed heads.

(2) Since containers for cabbage have not been standardized, many different types are used. The western crate and the half-crate, holding 85 to 100 pounds and 45 pounds respectively, are used extensively. Other containers are the 1½-bushel hamper, half-barrel crate, pony crate, 50-pound wire-bound crate, and 50- to 100-pound sacks.

c. Inspection.—(1) The chief defects of cabbage are worm injury, decay, yellowing of the leaves, and burst heads. Cabbage that is badly affected by these defects should be discarded, but if only slightly affected, it may be trimmed and utilized to advantage. The elements of quality that are considered for U. S. No. 1 grade include type, trimming, solidity, freedom from withering, puffiness, bursting, soft rot, and damage caused by discoloration, freezing, diseases, and insects.

(2) New cabbage that has been improperly handled soon loses its freshness. Freshness of appearance is very important in the early crop; in the late crop, which may be trimmed down to good, white heads, it is less important.

(3) Cabbage which has yellow leaves or other discoloration is generally past its prime or may be affected by some form of injury. Sometimes examination will reveal that the base of some of the outer leaves has separated from the stem, and that the leaves are held in place only by the natural folding. Such cabbage when cooked may be strong in flavor and coarse in texture.

d. Diseases.—The most serious diseases of cabbage are bacterial soft rot, gray mold rot, rhizopus rot, watery soft rot, and black rot.

(1) *Bacterial soft rot* causes more destruction of cabbage on the market and in storage than any other disease. This is due to the fact that bruised tissues are readily susceptible to bacteria. Symptoms are a soft, mushy, sticky decay and a very offensive odor. The disease may be spread in shipment or storage by contact or by oozing drippings of the decayed tissues. Warm storage favors the development of rot, with a temperature of 70°-80° F. as most favorable. Storage at 45° F. or below is safe.

(2) *Gray mold rot* occurs in old cabbage or cabbage in storage. It produces water-soaked, grayish-green color, and a gray mold is usually present on the surface of the affected tissues. High humidity favors its development.

(3) *Rhizopus rot* rapidly destroys cabbage stored at a high temperature, the temperature conducive to development being 75°-85° F. It is controlled at temperature of 35° F. or less.

(4) *Watery soft rot* is caused by a soil fungus which produces a soft watery decay and often a white cottony mold over the surface of the tissues. Its appearance in storage depends on moisture and temperature conditions. Moisture causes the fungus to spread rapidly.

e. Suggestions for use.—(1) Fresh cabbage should have an important place in the mess. It is rich in essential minerals and vitamins, and is obtainable at all seasons of the year. To obtain the best advantage as to minerals and vitamins, it should be eaten raw as a salad or cole slaw; it is also very valuable and palatable when boiled.

(2) Cabbage should be cooked by boiling it in an open kettle about 20 minutes, or until tender. It should not be overcooked. When it is correctly cooked most of the natural green color should be retained. When it is boiled, it is usually added to corned beef; or a ham hock or bacon is added for seasoning. Left-over boiled cabbage may be fried and is very savory.

17. CARROTS.—From the standpoint of their food and vitamin value and good shipping and storage qualities, carrots are considered one of the best of the early vegetables. California leads in the production of carrots, shipping over 13,000 carloads in 1943. The States of Texas, Arizona, New Mexico, and New York follow in volume of shipments in that order. Shipments from California, Texas, Arizona, and New Mexico are made up almost wholly of freshly pulled carrots either bunched or topped, while the shipments from New York consist mostly of large-sized, late-dug carrots which are topped, and frequently held in cold storage.

a. Varieties.—Although there are many varieties of carrots, only a few are of commercial importance: namely, Chantenay, Nantes, Coreless, Danvers Half Long, and Imperator. Crops of carrots are of two general classes: the northern or summer crop, much of which goes into storage or processing, and the southern or winter crop, which appears on the market during the winter in the form of bunched carrots. Crops are also classified as early and late. Early-crop carrots are usually harvested before reaching full maturity and therefore are generally smaller, of a brighter color, and a milder flavor than those of the late crop. Late-crop carrots are generally grown to full maturity and possess a deeper color and more pronounced flavor than those of the early crop. In some late-crop varieties the core of the carrot may be tough and woody.

b. Marketing.—(1) The early-crop carrots are usually marketed in bunches which contain five to eight carrots of similar size. The late-crop carrots are plowed out, topped, and placed in containers for storage.

(2) Bunched carrots are packed largely in slat crates measuring 13 by 18 by 22 inches inside and holding six dozen bunches with the tops on. The crates are lined with a special crate-lining paper, and while the bunches of carrots are being packed in the crates a quantity of finely crushed ice is added. When the crates are properly filled and headed up, they have a decided bulge. After they are loaded in the car a layer of crushed ice 6 to 8 inches thick is spread over the top of the load. Winter shipments

do not require bunker ice unless they are to pass through warm territory; but, when shipments are made during hot weather, bunker ice, in addition to the top icing, is used. (In south Texas a smaller crate measuring 9 by 13 by 22 inches is frequently used for the shipment of bunched carrots.)

(3) Large quantities of carrots are stored in the fresh state and held for marketing, for canning, for use in the making of soup, for stock feeding, and for other purposes. Well-regulated cold storage is satisfactory, but good results may also be obtained in natural storage cellars or outdoor caves, where a cool temperature without freezing is possible. Banks or pits are also used for storage. A moderately moist atmosphere is desirable, in order to prevent shriveling, and the temperature should be kept between 32° and 34° F. Before carrots are stored the tops should be cut off about half an inch above the tubers.

c. Inspection.—(1) Carrots for Army use should be U. S. No. 1 grade, either bunched or topped, and should comply with the requirements of the U. S. Standards for Grades of Fresh Carrots.

(2) Carrots of good quality are firm, clean, fresh in appearance, smooth, well shaped, and of good orange color. Poor color is often associated with poor quality. The tops of bunched carrots should be fresh and green. The condition of the tops is an indication of quality, but is not always a trustworthy one, since they may be damaged and the roots still remain in prime condition.

(3) Carrots that are wilted, flabby, soft, or shriveled are undesirable. Those showing excessive thick masses of leaf stem at a point of attachment or "neck" usually have undesirable large cores or hearts.

d. Suggestions for use.—Carrots may be regarded as a staple vegetable in the kitchen. They may be baked, boiled, and served with drawn butter or white sauce, diced and creamed with peas, fried and used for seasoning soups and meats, or grated (raw) and used as a salad either alone or mixed with cabbage or raisins. They should be cooked in a small amount of water, in either a steamer, or a pressure cooker.

18. CAULIFLOWER.—Cauliflower was formerly of little commercial importance in the United States, but it has gained in popularity largely because of better transportation facilities and of the development of seeds which produce firm, smooth, white, well-rounded flower beads or curds. In order to produce the white heads demanded on the market, it is necessary to protect the young heads from the sun by folding and tying the large leaves over them, or by providing some other covering to check the development of the chlorophyll. The production regions are largely in California, New York, Colorado, Arizona, New Jersey, Washington, and Oregon.

a. Varieties.—Cauliflower varieties are classified as early and late. Well-known early varieties are Early Dwarf Erfurt, Early Snowball, and Early Pearl. Well-known late varieties are Late Pearl and Autumn Grant.

b. Harvesting and marketing.—(1) Great care must be taken to cut the heads at the right stage of maturity; otherwise floral parts develop too much. In the best cauliflower the outer leaves are green, the enclosed head is creamy white to white, and the bud clusters are crowded close together forming an even, firm head.

(2) In preparation for shipment, the protective leaves are usually trimmed down to as much of the outer leaves as will afford protection to the curd. The number of leaves left on the head has no relation to quality, since the leaves are merely to protect the tender curd, which is very easily bruised and broken. Sometimes wrapped and trimmed heads of cauliflower are found on the market. Such heads have been very closely trimmed and paper has been used to protect the curd. Size has little relation, if any, to quality. Large or small heads, equally mature, are equally good.

(3) Cauliflower, because of its nature, is generally packed in crates. One of the most commonly used sizes is the California pony crate, which measures 8½ by 18 by 23¼ inches inside, with an outside length of slat of 24½ inches. The number of heads packed in this pony crate usually varies from 12 to 15. The most commonly used eastern cauliflower container is the crate used in the Long Island and Catskill sections, and measuring 13 by 15 by 21⅝ inches.

c. Defects and diseases.—(1) Cauliflower is subject to the same diseases as cabbage (see par. 16*d*). The most troublesome diseases are bacterial soft rot, black rot, brown rot, clubroot, gray mold rot, ring spot, and watery soft rot.

(2) Development of the colorless leafy bracts in the flower heads leads to a condition known as "fuzzy," "barber," and "old man." When the beads begin to spread so that the individual buds are separated, the condition is referred to as "riceyness." Unless these conditions are very severe they do not affect marketability. Another type of spreading, or opening, is caused by excessive shrinkage due to water loss. This occurs in cauliflower that has been held for a long time, while the spreading due to overmaturity takes place within a few days after the stock is cut.

d. Inspection.—(1) Cauliflower for Army use should be U. S. No. 1 grade and should comply with the requirements of the U. S. Standards for Grades for Fresh Cauliflower.

(2) Fine quality in cauliflower is indicated by a white or creamy-white, clean, firm, compact curd, with outer leaves, fresh, turgid, and green. A

compact curd is one that is solid, with the flower clusters closely united.

(3) A spotted, speckled, or bruised curd should not be used unless it can be trimmed without causing too much waste.

e. *Suggestions for use.*—Cauliflower should be boiled in an open kettle for about 30 minutes or until tender. It may be served with cream sauce, drawn butter, or hollandaise sauce; it may also be served raw in salads. Leftovers can be used to good advantage in salads.

19. CELERY.—Celery ranks next to lettuce in importance as a salad crop. California, Florida, Michigan, New York, New Jersey, Colorado, and Oregon produce most of the celery crop of the country.

a. *Varieties.*—There are two distinct varieties of celery: Yellow or summer celery, of which the Golden Self-Blanching is typical, maturing early and blanching easily; and green or winter celery, of which the Grand Pascal is typical, maturing later and having greater weight and better quality than the early yellow variety. The public has recently become aware of the fact that Pascal types have better flavor, keeping quality, and nutritional value without blanching, and the popularity of green celery has increased by leaps and bounds.

b. *Marketing.*—(1) Much of the celery sent to market is shipped in the rough. This means that it has been trimmed only to remove damaged and sprouting side stalks and most of the roots. It is then sized and packed. Rough celery is sometimes offered for sale but is usually trimmed and washed in the receiving market. Sometimes it is trimmed down to the heart because the outside stalks are pithy or rotten. The hearts are sold by the bunch, and the good outer branches are bunched and sold for culinary purposes. Washed and trimmed celery is also shipped from the producing centers.

(2) Celery must be shipped in specially designed crates and boxes. The California crate, sometimes referred to as the full-sized or standard crate, measures 22 by 24 by 20⅜ inches inside. The crate used to the greatest extent in Michigan and New York is generally called the "two-thirds crate." New York has by law fixed the inside dimension of this crate as 22 by 16 by 20¾ inches. The Florida crate is sometimes called the "one-half crate." It measures 20 by 10 by 22 inches inside and is used for the shipment of most Florida celery. Florida shippers are the only ones who make a practice of sizing their rough celery, which they pack 3, 4, 6, 8, or 10 dozen branches to the crate.

(3) Michigan is the principal State using special containers for washed celery. Both boxes and crates are used. The crate is known as the "hi-ball" and is standardized only as to its ends, which measure 12 by 18 inches. Celery packed in these crates is sold by the dozen bunches, and the varia-

tions in length are used to fit the crate to the number of dozens it is desired to pack. The boxes used are called flats and squares. The flats are 14 inches wide, and vary in depth from 5 to 7 inches and in length from 16 to 24 inches. The squares have ends measuring 9 by 9 inches and vary in length from 12 to 20 inches.

c. Inspection and quality.—(1) The most desirable celery is that of medium length, thickness, and solidity, with branches that are brittle enough to snap easily. Such celery usually has a good heart.

(2) Pithy or stringy celery is undesirable. Pithy branches are those of open texture with air spaces in the central portion. Pithiness may be due to freezing or to a hereditary defect present during the entire life of the plant. It can be detected by pressing or twisting the branches; stringiness can be detected by breaking the branches.

(3) Celery that has formed a seed stem has poor flavor and may be somewhat bitter. The seed stem can be seen by separating the branches; the typical heart formation is replaced by the development of a solid roundish stem of varying size, depending on the stage of development.

(4) Injury from freezing may be detected by twisting an affected branch which results in a general loosening of the epidermis. It may cause a browning and drying of the tops, which may later decay.

d. Suggestions for use.—Celery is obtainable the year round and is not expensive. It should be widely used in the service messes. It can be used raw in salads and is especially good when used with a fish or meat salad. It imparts a good flavor to cooked foods and the trimmings can be used in soups or chop suey. It provides excellent roughage.

20. CHARD.—Swiss chard, or chard as it is known on the markets, is similar to the garden beet in its habit of growth, except that it grows almost entirely to tops and does not form an enlarged root. Louisiana and Illinois produce most of the chard crop during November to March, and June to August, respectively.

a. Variety.—The Lucullus variety is considered the best and is marketed in the summer and fall from local sources.

b. Inspection.—The leaves of chard should be crisp, tender, fresh, and free from insect injury. The stalks should be fleshy and crisp. Those that are wilted or rubbery may be tough, coarse, and stringy. Coarse stalks indicate pithiness, the presence of which may be discovered by pressing or twisting the stalk. Yellowed leaves or discolored stalks are indications of age or other damage that may cause toughness.

c. Suggestions for use.—Chard stems and tender leaves make excellent summer greens, and are cooked exactly as beet or other greens.

21. CHICORY, ENDIVE, ESCAROLE.—*a. Varieties.*—Chicory or Witloof chicory, sometimes called French endive, is grown for both root and tops. It is broad-leaved and of upright, spreading growth. The tops are harvested early and are boiled and served in a manner similar to that in which spinach is served. Endive, also known as escarole, closely resembles lettuce in its requirements and habits of growth except that it is not sensitive to heat. In the South it is mainly a winter crop. The Broad-Leaved Batavian and Moss-Curled varieties are the two most commonly produced. Endive has a leaf that is narrow, finely divided, and curly. Escarole is a broad-leaved plant. Both are flat and of spreading growth.

b. Harvesting.—The chicory roots are dug in the autumn and placed in a box or bed of moist soil in a warm cellar for forcing. They must be covered with a foot or two of manure or a few inches of sand. Under this covering the leaves form in a solid head which is known on the market as Witloff.

c. Inspection.—Crispness, freshness, and tenderness are the essential elements of quality. Wilted plants can be freshened by being placed in water; they may be wasteful and should be examined for decay, which may appear as a browning of the leaves or as a slimy rot. Tough, coarse-leaved plants are undesirable, for the usual delicate, bitter, flavor is likely to be so intensified as to be objectionable. Toughness or tenderness can be determined by breaking or twisting a leaf.

d. Suggestions for use.—Chicory, endive, and escarole are not adapted to long storage. Under best storage conditions, at 32° F., they will keep for 2 or 3 days. Blanched chicory leaves may be used as a raw salad or cooked and served like spinach or chard. When cooking chicory leaves it is necessary to change the water once or twice to remove the bitterness.

22. COLLARDS.—*a. Varieties.*—Collards are botanically similar to kale and have an appearance similar to that of cabbage. They do not form a head, but the leaves are large and are slightly curled at the edges and lightly folded at the heart. There are several varieties, some producing large plants and others small plants. The principal sources of commercial supply are Virginia, Georgia, Louisiana, Texas, New Jersey, Illinois, and New York. Bushel baskets, crates of various sizes, basket barrels, and other containers are used for shipping collards.

b. Inspection.—Collards of good quality are fresh, crisp, clean, and free from insect injury. Wilting and yellowing of the leaves indicate age or other form of damage. Sometimes worm injury may be found in the form of perforated leaves. Collards with such leaves are undesirable. In general, collards are subject to many of the diseases that affect cabbage (see par. 16*d*). In shipment and on the market, bacterial soft rot is the disease most destructive to this vegetable.

c. Suggestions for use.—Collards are grown mainly in the South for use as greens during the winter, and their flavor is improved by a touch of frost. They should be cooked in the same way as cabbage (see par 16*e*).

23. CORN (SWEET).—The United States grows about three-fourths of the world's supply of corn.

a. Varieties.—Corn found on the market is of two classes, sweet and field. The latter is usually an early maturing variety of field corn, and is known in some sections as roasting ears. It may be as tender as sweet corn, but it never has a notably sweet taste. The ears of sweet corn are usually smaller than those of field corn, and the shucks are generally darker green with ribbonlike ends which hang free and give the ear a somewhat ragged appearance. The color of sweet corn may be either white or yellow depending on the variety. Some of the more common white varieties are Country Gentleman, Early Evergreen, Early Market, Howling Mob, and Stowell Evergreen. Common yellow varieties are Bantam Evergreen, Golden Bantam, Golden Cross Bantam, Golden Early Market, and Golden Gem. The grains of most varieties form straight rows. Those of Country Gentleman form irregular rows.

b. Marketing.—The most popular shipping container for sweet corn in recent years is the open-mesh sack designed to hold about five dozen medium-sized ears. Various sized crates used extensively in the past are rapidly disappearing from the picture. For local marketing, the use of burlap sacks is common. These usually contain five dozen ears or some other count.

c. Inspection and quality.—(1) Sweet corn for Army use shall be of U. S. No. 1 grade and shall comply with requirements of the U. S. Standards for Grades of Sweet Corn.

(2) A good quality of corn is one that has a fresh green shuck and a cob that is free from worms and is well filled with bright, plump, milky grains just firm enough to offer slight resistance to pressure. The grains which are tender are plump and milky, and when pressed with the thumbnail they are easily punctured and the milk spurts out. Only freshly gathered corn is satisfactory, as it does not keep well after being harvested.

(3) It cannot be expected that all the ears will be completely covered to the tip end with grains. If the grains look withered or have a glazed appearance, the corn is old and tough. When inspecting, look for ears that have been injured by worms, or have wilted discolored shucks. Worm injury is not serious when confined to the tips, since the injured part can usually be removed with little waste; it is more objectionable if it occurs

along the side of the ear. Quality can best be determined by pulling back the shuck and examining the grains. Corn that is too mature is unsatisfactory, since the grains are tough and dry, and lack flavor and sweetness. If immature it is watery and lacks sweetness and flavor.

(4) Dry, yellowed, or straw-colored shucks are an indication of age or damage. Corn heats rapidly when packed for shipment. Heating causes the yellowing and drying-out of the shucks as well as the toughening, discoloration, loss of flavor, and shriveling of the grains. When wormy tips are discovered they should be cut off and the worm shaken out, if found to be still in the ear.

d. Suggestions for use.—Sweet corn is usually boiled on the cob with water, salt, and pepper. Leftovers can be used for corn fritters, succotash, and many other dishes.

24. CUCUMBERS.—Cucumbers are grown in practically every State for either home use or commercial use. Those for commercial use are shipped to either fresh markets or to processors for conversion into pickles. Florida produces about one-third of the entire United States cucumber crop.

a. Varieties.—Cucumbers of the white-spined type are the ones commonly produced. The newest varieties are characterized by their dark-green color and the ability to retain this color during shipment. The Stays Green, A. and C., Black Diamond, and Longfellow varieties are the most popular of this group. Maturing early, they are from 6 to 8 inches in length and from 2 to 2½ inches in diameter. Early Fortune, another popular white-spined variety, is slightly longer and matures several days later than the above-mentioned varieties.

b. Marketing.—(1) The marketing of fresh cucumbers is divided into three seasonal periods; early, intermediate, and late. The early period extends from April to July; the intermediate period extends from June to August; and the late period extends from August to November.

(2) Prior to packing, the cucumbers are graded into fancy, choice, and culls. The first two grades are packed in either bushel baskets, hampers, bushel crates measuring 12 by 12 by 15 inches, or boxes containing 24 cucumbers.

c. Inspection.—(1) Cucumbers for Army procurement shall be U. S. No. 1 grade and shall conform with the requirements of the U. S. Standards for Grades for Cucumbers.

(2) Fresh cucumbers for table use must be fresh, crisp, medium-sized, well-formed, and of a dark-green color over at least two-thirds of their length.

(3) Cucumbers that are withered or shriveled have a tough or rubbery

flesh and a bitter flavor. Overmaturity is indicated by a generally overgrown, puffy appearance. The color of overmature cucumbers is generally dully and frequently yellowed; the flesh is rubbery and tough; the seeds are hard; and the flesh in the seed cavity is almost jellylike.

d. Suggestions for use.—Cucumbers may be used in the mess as a salad by themselves, in combination with other vegetables, or sliced and served in vinegar or a sour or sweet-sour sauce.

25. EGGPLANTS.—The eggplants grown for market are large and fleshy, and either ovoid, round, or oblong. They are a very important crop in the Orient, but only a minor crop in this country. Since they are of tropical origin, they are grown in the North in those sections having warm summers. In the South they may be grown during spring, summer, and autumn.

a. Varieties.—The dark-fruited or purple varieties—Black Beauty, Florida High Bush, Improved Large Purple, and New York Purple—are most extensively grown for commercial use.

b. Marketing.—(1) Eggplants are considered properly matured and of good quality after they have reached sufficient size—a diameter of 4 inches or more—have a uniform dark color, and are heavy, firm, and free from blemishes. Those which are wilted, shriveled, soft, or flabby, as a result of having been harvested too soon, or handled improperly, or stored too long, are usually bitter and of poor flavor.

(2) Eggplants are marketed in many different types of containers. In local market-garden productions, where the crop is usually hauled direct to market, they are placed in hampers and baskets and sold by the piece or by the pound. For shipment, they are wrapped and packed in crates. The standard Florida pepper crate, which is 11 by 13⅜ by 22 inches, is widely used.

c. Diseases.—Like tomatoes, eggplants are subject to many diseases, of which anthracnose, fruit rot, and cottony leak are the most damaging. Of these fruit rot is the most common and the most destructive. It produces somewhat circular, light-brown spots which darken with age and spread over the surface of the fruit. The decay, which is soft and spongy, penetrates the tissue and causes a light-brown discoloration.

d. Suggestions for use.—Eggplants may be fried in deep or shallow fat; baked au gratin; or baked and mashed. They may also be sauteed, creamed, stuffed, or prepared with other vegetables. Properly prepared, they are popular and economical in season. Unfortunately, most cooks are not particularly familiar with them and therefore do not appreciate their true worth.

26. GARLIC.—Garlic is grown commercially chiefly in California,

Louisiana, and Texas, and is usually harvested in April or May. A garlic bulb is formed by a varying number of cloves, each in its own papery skin or sheath, and all enclosed in an outer skin or sheath. The cloves are usually variable in size, those at the outer edge of the bulb being larger than those in the center.

a. Varieties.—Three distinct varieties of garlic are being grown; namely, the Creole or American, the Italian or Mexican, and the Tahiti. The Creole variety grows much taller than the Italian, and the skin that surrounds the cloves is distinctly white. It has a stronger flavor than the other varieties. The Italian has many individual cloves, and the sheath covering them is usally pink. It usually matures about 2 weeks earlier than the Creole. The Tahiti is 2 to 3 inches in diameter and is more resistant to thrips than the other two varieties. It has a large bulb containing four or five large cloves.

b. Marketing.—Like onions, garlic is marketed loose with tops removed, and in 10-pound bags, or with the tops attached and plaited in strings of 50 or 100 bulbs to the string. There is no accepted package for shipping garlic. Since it is usually sold by the pound or string, a slotted crate permitting good ventilation would probably be most desirable.

c. Suggestions for use.—Garlic is used to advantage in seasoning meats, gravies, sauces, soups, salads, and salad dressings. It must be used with judgment, as many persons do not care for any flavor of garlic, and to most persons a pronounced garlic flavor is objectionable. A delicate garlic flavor may be obtained by rubbing the inside of the cooking utensil or salad bowl with a cut clove of garlic; or the meat may be rubbed. Finely minced garlic may be added to any of the dishes mentioned above, but care must be taken not to use an excessive quantity. A delicate flavor of garlic makes all meats, especially roasts, more savory and appetizing, and gives a tang to soups, stews, and salad dressings which is very appealing. Such a flavor can be obtained by using a garlic essence. To make garlic essence, soak 1 quart of cloves in 3 quarts of olive oil. Before soaking, separate the garlic cloves and remove the dry skin. A little of the essence can be rubbed around the inside of the cooking utensil or on the surface of meat.

27. KALE.—Kale, a member of the cabbage family, grows in almost any garden soil and requires little attention. It is cheap and abundant in winter. The South Atlantic Coast States furnish most of the kale in the winter markets.

a. Varieties.—The Scotch Curled and Siberian are two of the most popular garden varieties. These consist of low-growing, spreading plants, with thick, more or less crinkled leaves.

b. Inspection.—(1) Kale of good quality is usually of a dark or bluish-green color, clean, and with a fresh appearance. Some kale has a bronzed or brownish appearance, which is not attractive, but the flavor is usually not harmed, as the condition is probably brought about by cold weather during the growing period. Plants with wilted and yellow leaves should be avoided, unless they can be trimmed without too much waste. Old kale is poorly flavored and has tough, stringy texture.

(2) For Army procurement, kale should be fresh, tender, clean, normally developed, green in color, and practically free from damage caused by plant lice and other insects, overheating, disease, decay, or other defects.

(3) Kale may be harvested either by cutting the entire plant or by taking the larger leaves of the plant. Before being packed for shipment, it should be carefully inspected for the presence of aphids, insects very injurious to it.

28. LETTUCE.—Lettuce is the most important salad plant and one of the most important of the vegetable crops. It is in demand at all seasons of the year, and is probably grown under more varied conditions in greenhouses and in field culture than any other vegetable. The commercial producing area of the United States can be divided into three regions: namely, the Western, including the Pacific Coast and Rocky Mountain States; the Northeastern, including Massachusetts, New York, and New Jersey; and, the South Atlantic States, including North Carolina. The Western States produce approximately 85 percent of the entire crop of "Western Iceberg" (New York) lettuce, while the Eastern and Southeastern States produce most of the Big Boston crop. The climatic conditions of the East and Southeast do not favor the growth of crisp head lettuce.

a. Varieties.—In general, four varieties of lettuce appear in the market; namely, the crisp head, the butter head, cos or romaine, and leaf lettuce.

(1) *Crisp head (or Iceberg type)* is distinguished by a very firm head of crisp texture. The most popular type is the New York, a very large, dark-green, solid, late, crisp head lettuce. A new variety, Great Lakes, is increasing in popularity because of its dependability in growth and quality.

(2) *Butter head* is distinguished by a soft head, the inner leaves of which feel oily to the touch. This variety is represented largely by the Big Boston and White Boston types. Formerly, butter head lettuce was the principal variety grown for the eastern market, but it has now been displaced by the crisp head variety.

(3) *Cos or romaine* is distinguished by elongated heads, stiff leaves, and an upright habit of growth. This variety has never been popular in the

United States but is highly prized in Europe. There is a limited market for this variety of lettuce among the foreign population of the larger cities. Although cos lettuce is crisp in texture, the best types—Paris White cos and Dark Green cos—are of superior quality, lacking the bitterness so often present in other types, especially in some of the crisp head types.

(4) *Leaf lettuce,* as the name implies, does not head, and has either a much curled or a somewhat smooth leaf, and a crisp texture. The Grand Rapids is the most popular type of leaf lettuce.

b. Packing and shipping.—(1) California has standardized its lettuce crate, requiring that it shall measure 13 by 18 by 24½ inches inside. Arizona, Colorado, Idaho, and Washington use the same crate. This crate is used for packing from 36 to 90 heads of lettuce, depending on the size of the heads, and the law requires that it shall be conspicuously stamped with the exact number of heads contained. Growers from other sections of the country usually stamp the container with the number of heads it contains. New York has a standard crate measuring 7½ by 16 by 19 inches, inside. It is believed that this crate will come into general use in the Atlantic Coast States. Florida moves much of its crop in 48-quart hampers, and North Carolina used 40-quart hampers.

(2) Leaf lettuce is marketed in several kinds of containers, such as lug boxes and second-hand vegetable, sugar, and flour barrels. The hothouse-lettuce growers of northern Ohio use a square-cornered, 10-pound split basket.

c. Inspection.—(1) Lettuce for Army use should be of U. S. No. 1 grade, and should comply with the requirements of the U. S. Standards for Grades for Lettuce.

(2) Crisp head lettuce, to be of good quality, should be fresh, tender, and fairly firm to hard. It should be free from decay and not have an excess of outer or wrapper leaves. Occasionally, lettuce that has well-developed seed stems is found on the market; such lettuce usually has a bitter flavor and is wasteful.

(3) A seed stem that is objectionable, although it may have not burst through the head, can usually be detected by wide spaces between the outer leaves at their base and a knoblike swelling protruding beyond the normal contour of the head. The swelling is usually at the top but may be at the side of the head; if pressure is applied at this point a hard core can be felt. In some types this condition is frequently accompanied by a purplish tinge on the outer edges of the leaves.

(4) Dead or discolored areas on the outer leaves may be an indication of decay. Sometimes a soft rot is found that penetrates the interior of the head. Broken, ragged, bruised, or wilted leaves are unattractive but usually

do not affect the quality of the head. Generally, these defects and even decay, if not too severe, may be removed by trimming. Trimming lettuce to remove defects and improve appearance is a common practice on all markets. It is often economical to purchase trimmed lettuce.

d. Suggestions for use.—Lettuce is an outstanding vegetable in nutritive value and should have an important place in every Army mess. It should be chilled and crisp and served with a Thousand Island or French dressing. It can be used as a salad or in combination with other vegetables. Trimmings can be used in soups, or for garnishing. It is not necessary or desirable to serve large portions of lettuce. When head lettuce salad is served, the ordinary-sized head should be cut into eighths. One leaf is sufficient as a base for fruit or vegetable salads; it should be pulled into small pieces, as otherwise it may not be eaten.

29. OKRA.—Okra is cultivated in warm climates for its young mucilaginous pods.

a. Varieties.—The more common varieties are Perkins Mammoth, Dwarf Green Prolific, White Velvet, and Lady Finger. Okras may be either green or white and may have either long or short pods, some of which are more ridged than others. Personal preferences will decide which is the best.

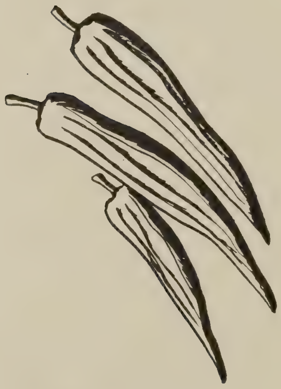


Figure 6.—Okra.

b. Harvesting and marketing.—(1) Okra pods of best quality should be harvested when they are young and tender. Pods are of proper maturity if they snap easily when broken and are easily punctured.

(2) Okra pods are marketed in hampers and in six-basket crates. A round-stave bushel basket is used in shipments from Texas. As only a small quantity of okra is raised, most of the shipments are made by express.

c. Inspection.—Pods that have passed their prime present a somewhat dull, dry appearance. They are hard, woody, and fibrous, and the seeds are hard. Those that are stored for too long a period are likely to be shriveled, discolored, and of poor flavor.

d. Suggestions for use.—Okra pods are used in soups and meat dishes, usually being sliced transversely for this purpose. When used in this way, they have a thickening effect and add considerable flavor to the dishes. They may also be sliced and served raw in salads, boiled and served with drawn butter or hollandaise sauce, or fried.

30. ONIONS (GREEN), LEEKS, AND SHALLOTS.—*a. Varieties.*—The green bunched onion may be an early onion, usually white, that is gathered before maturity, when it has reached the required size. The leek, a plant similar to the onion, has broad, dark-green leaves and a straight, thick, white neck about 1 inch or more in diameter. It has an agreeable but not strong flavor, and is used cooked or raw, usually for flavoring. The shallot is related to the onion and grows in oblong clusters which are gathered before maturity. The mature shallot is used chiefly for flavoring. Green onions, leeks, and shallots, as they appear on the market, are merely blanched leaf bases or incompletely developed bulbs, together with the green portions of leaves. They are usually sold in crates containing five dozen bunches. Green onions differ from the shallots in that they are somewhat bulbous at the base whereas shallots are practically a straight stem. Leeks, much larger than shallots, have a rounded but not bulbous base.

b. Inspection.—(1) Green onions, leeks, and shallots of good quality have green fresh tops, and medium-sized necks which are well blanched for at least 2 or 3 inches from the root and young, crisp, and tender.

(2) Bruised, yellowed, wilted, or otherwise damaged tops are not attractive and may indicate poor quality or damaged necks. The wilting and yellowing of the tops may indicate age and flabby, tough, fibrous necks. This condition can be ascertained by puncturing with the thumbnail and twisting. Bruised tops are unimportant if they can be trimmed without waste or spoiling the appearance for table use.

c. Suggestions for use.—Green onions may be served alone as a fresh vegetable, or combined with other raw vegetables as a salad. The tops can be used for seasoning of soups or dressings. Leeks are used either raw or cooked, usually for flavoring. Shallots are used chiefly for flavoring.

31. PARSLEY.—Parsley is a member of the same group of plants as celery, celeriac, carrots, and parsnips. Although it has been used for many years, it has not attained great commercial importance.

a. Varieties.—Two varieties of parsley are available: the well-known foliage variety, which is used for garnishing and for flavoring soups and stews, and the turnip-rooted variety, which is used like other root crops.

(1) Foliage parsley is of two types: the moss or curled-leaved, and the plain-leaved. In quality they are alike, but the curled-leaved is more attractive and is grown almost exclusively. The Moss-Curled, the Doubled-Curled, and the Plain-Leaved are the most common types grown.

(2) The turnip-rooted variety, of which Hamburg is the leading type, is usually listed as turnip or thick-rooted parsley.

b. Inspection.—(1) Parsley is judged mainly from its general appearance. It should be bright, green, fresh, and free from dirt and yellowed leaves.

(2) Wilting and yellowing of the leaves denote age or damage; damage is sometimes caused by bad handling. Slightly wilted parsley can be revived by placing it in cold water. Badly wilted parsley is unattractive and practically worthless.

c. Suggestions for use.—Parsley is used mainly for seasoning and garnishing. A little chopped parsley greatly improves the appearance and palatability of many dishes.

32. PARSNIPS.—Parsnips are essentially a winter vegetable and are adapted for growing throughout the northern part of the United States.

a. Varieties.—The Hollow Green and the Guernsey are the varieties most commonly grown for the commercial market.

Figure 7.—Parsnips.

b. Harvesting.—Parsnips may be dug and stored in a cellar or pit or left in the ground until used. Those placed in cold storage gain in quality faster than those left in the ground. However, freezing parsnips in the ground in winter improves the quality. There is no basis, however, for the belief that those that remain in the ground over winter and start growth in the spring are poisonous. The reported cases of poisoning from eating so-called wild parsnips have all been traced to water hemlock, which belongs to the same family.

c. Inspection.—Parsnips of best quality are smooth, firm, small- to medium-sized, and well-shaped. Those which are soft, flabby, or shriveled are usually pithy or fibrous. Softness is sometimes an indication of decay which may appear as a gray mold or water soft rot. Large, coarse parsnips are likely to have woody cores. Those which are misshapen are objectionable chiefly because of waste in preparation for table use.

d. Suggestions for use.—Parsnips are not liked by all persons; however, they could become well liked in Army messes if prepared in accordance with the recipes given in The Army Cook.

33. PEAS.—Peas are grown for market in the cool weather regions of the United States. California is the largest producing region of market peas, producing about one-half of the total United States supply.

a. Varieties.—There are two varieties of peas based on the seed: The smooth-seeded and the wrinkled-seeded. The Alaska is the most important type of the smooth-seeded variety. Some of the early types are Alaska Gradus, Laxton Progress, Little Marvel, and Thomas Laxton. Second early types are Asgrow 40, Giant Stride, Midseason Grant, and Morse

Market. Late types are Alderman and Telephone. New and improved types of peas are being developed so rapidly that any recommended list is soon out of date.

b. Harvesting and marketing.—Peas are harvested when the pods are well filled with young, tender peas, changing in color from a dark to light green. Peas for market or shipment are packed in baskets, hangers, or boxes. The round-stave bushel basket and bushel tub basket holding about 28 pounds are most generally used.

c. Inspection.—(1) Peas for army use should be of U. S. No. 1 grade and comply with the requirements of the U. S. Standards for Grades for Fresh Peas.

(2) The quality of peas is associated with the starch-sugar ratio. High sugar and low starch contents make for high quality. During maturity there is a rapid decrease of sugar and soluble nitrogenous substances, and an increase of starch with an accompanying increase in toughness of the skin. Thus, peas lose their sweetness and delicate flavor as they mature. Whatever the stage of maturity of the peas purchased, care should be taken to see that the maturity is about the same throughout the lot to insure uniformity in cooking.

(3) Pods of immature peas are usually flat, dark green in color, and may have a wilted appearance. A yellowish color indicates age or damage. Peas of such color have poor flavor and are too tough for satisfactory use. Water-soaked pods should not be used for the peas are likely to be washy and of poor quality.

d. Suggestions for use.—The use of fresh peas in the mess is seldom economical from a financial standpoint, as they usually cost more (for net weight) than canned peas; however, the flavor of fresh peas is preferred by many persons to that of canned peas. Peas are usually cooked in boiling, salted water, until tender, which requires from 5 to 20 minutes, depending on maturity. Butter may be added for seasoning; or, at the end of the cooking, milk, or milk and flour or flour and water batter may be added. Any left-over cooked peas may be added to salads, or they may be added to soup cooked or uncooked.

34. PEPPERS (SWEET).—Two types of peppers are found on the market: the sweet type and the hot type. Chili or cayenne peppers belong to the hot type.

a. Varieties.—Sweet peppers are usually of the bell or bull-nose type. Chinese Grant, Ruby King, World Beater, and California Wonder are among the leading types; they are large-sized, thick, and firm. The types are diversified in shape; some are long and somewhat slender, others are short, chunky, and wide. The latter are more desirable for stuffing.

Figure 8.—Sweet pepper.

b. Marketing.—Sweet peppers are marketed in both the green- and red-colored stages of maturity. Green-colored peppers, though mature, will change to a bronze-red or bright-red color as they continue to mature. The Florida pepper crate is most commonly used in shipping. It measures 14 by 11 by 22 inches and holds approximately $1\frac{9}{16}$ bushels. Other containers in use are the 1-bushel and 1½-bushel hampers.

c. Inspection.—(1) Peppers are considered mature and of good quality if they are firm, well-shaped, and thick-fleshed, and of good size, uniform color, and fresh appearance.

(2) Immature peppers are usually soft, pliable, thin-fleshed, poorly colored, and their seed are underdeveloped. Firm peppers may yield to slight pressure, but they should not be shriveled, limp, or pliable. Peppers that have been kept too long are usually in this condition, and are often poorly colored. Crooked, constricted, deformed peppers, if they are of good quality otherwise, are objectionable only because of their limited use and the possibility of waste.

d. Diseases.—Peppers are attacked by bacterial soft rot, buckeye rot, and rhizopus rot; they may also be affected by sunscald, freezing, and blossom-end rot. Those affected by freezing have a water-soaked, flabby texture and the skin has a tendency to blister or rub off. As the water evaporates from the affected tissues the walls collapse and the whole pepper becomes worthless. To insure against freezing injury, all peppers should be protected against a temperature of 35° F. or below. Injury at the blossom end may result in blossom-end rot.

e. Suggestions for use.—(1) Sweet peppers are one of the richest vegetables in vitamins and for this reason are best served raw. The often-used method of stuffing them with ground meat and baking them destroys most of the vitamin C value; however, since vitamin C can be obtained from other sources, stuffed peppers are recommended for Army mess.

(2) Sweet peppers are a valuable addition to salads. A small quantity of sliced or slivered-green or red sweet pepper in salads, especially in cabbage salad, adds greatly to appearance. A little sliced green pepper added to stewed tomatoes gives a fine flavor. Small pieces of green or red sweet pepper are valuable as garnish on many dishes.

35. PUMPKINS.—*a. Varieties.*—Pumpkins are of three principal varieties: Mammoth, grown mainly for exhibition purposes; Field, grown

mainly for stock feeding; and Pie, grown mainly for making pumpkin pies. Almost any variety of pumpkins may be used for making pies, but some are especially adapted to this purpose. They are finer grained and sweeter than the other sorts. Small Sugar and Connecticut Field are well-known, orange-yellow-skinned types. Kentucky Cheese has a grayish-orange color with salmon-colored flesh.

b. Inspection.—Pumpkins of good quality have a rich, yellow color with no green showing on the rinds. The green part, if any, should be trimmed away to keep from imparting a bitter flavor to the pumpkins when cooked.

c. Suggestions for use.—Pumpkins should be cooked until tender in salted boiling water, or steamed, mashed, and seasoned with butter, salt, and pepper. They are used chiefly for pies. Since considerable preparation is required for this purpose, it is believed that canned pumpkin is satisfactory and more convenient to use; however, it may be more economical to use fresh pumpkin where it can be obtained at low cost.

36. RADISHES.—*a. Varieties.*—There are two general varieties of radishes: The mild, small, quick-maturing variety, such as Scarlet Globe, French Breakfast, and Cincinnati Market, all of which reach edible size in 20 to 40 days; and the more pungent, large, winter variety, such as Long Black Spanish and Rose China, which require 75 days or more for growth. Winter radishes are either blackish or white in color and are marketed with tops.

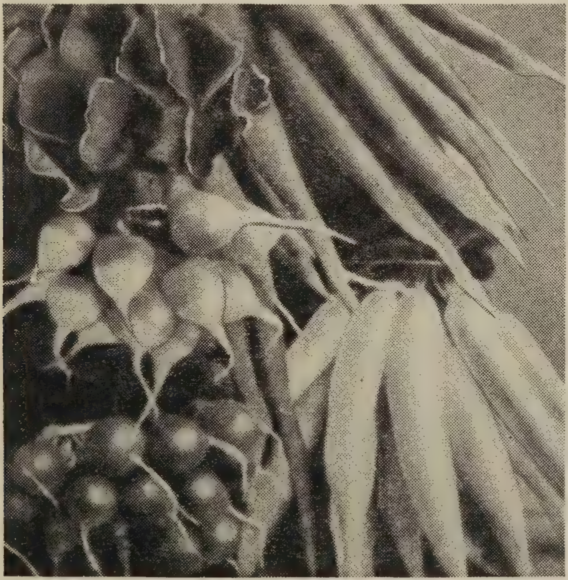


Figure 9.—Radishes.

b. Inspection.—(1) Good radishes are well-formed, smooth, firm, tender, crisp, and either mild or pungent in flavor, depending on the variety.

(2) The condition of the leaves is not always an indication of quality. While they may be fresh, bright, and green, the radishes may be spongy and pungent. They may be wilted and damaged in handling and have a generally poor appearance, while the radishes to which they are attached are not at all pithy.

(3) If the tops are coarse, dry, or yellow, the radishes may be old or may have been slow in growing. Old or slow-growing radishes are usually strong in flavor, and the flesh may be woody. Pithiness or sponginess is most undesirable; either may be detected by a slight pressure.

c. Diseases.—Radishes are frequently attacked by fungus diseases, the most common of which is black root. The first symptoms of the disease are small, grayish-black, surface discolorations about the base of the root. As the fungus penetrates the root, dark patches become visible under the epidermis and spread throughout the root.

d. Suggestions for use.—Radishes are valuable for vitamins and roughage. They are popular and should be served often (when reasonable in cost), either alone as a table relish, or whole, or cut in salads. Many meals are made more attractive by a few radishes; this is especially true of meals built around cold cuts of meat and potato salad. Radishes cut in round slices, or in a shape similar to that of a rosebud, or in fancy shapes, are valuable as a garnish.

37. RHUBARB.—*a. Varieties.*—Although rhubarb is distinctly in the vegetable classification from the standpoint of the producer and marketer, it is used entirely as a fruit and is logically considered a fruit by persons interested in its preparation for eating. There are two varieties of rhubarb marketed: The forced and the field-grown. Forced rhubarb is usually of a light, pale-pink or reddish color and has yellow-green foliage which is very underdeveloped. Field-grown rhubarb is usually dark red or green and rich in color, with a coarse, deep-green foliage. Forced rhubarb is on the market in late winter and early spring, and the field-grown during late spring and throughout the summer.

b. Inspection.—(1) Rhubarb of good quality is fresh, firm, crisp, tender, and either red or pink in color. The stalks should be fairly thick. Stalks that are well colored are usually well flavored; but some varieties on some soils show very little color. The younger stems on which the leaves are not fully grown are usually the most tender and delicate in flavor.

(2) Stale rhubarb usually has a wilted flabby appearance. It is unattractive and may be stringy and of poor flavor when cooked. Old rhubarb or that which has grown too long before being pulled may be pithy, tough,

and stringy. It is usually very wasteful. Tenderness and crispness can be tested by puncturing the stalk.

c. Suggestions for use.—Rhubarb is used mainly for sauce and pie. When cooked for sauce, only enough water should be added to prevent burning. Rhubarb contains such a large percentage of water that little additional is needed. The mixture of other fruits or fruit juices with rhubarb makes a very palatable sauce.

38. SPINACH.—Spinach is one of the leading vegetables grown as greens. It is a quick-maturing, cool-season crop and makes its best growth during the spring and fall. The growing of spinach for the commercial market is of most importance in Texas, Virginia, California, Louisiana, New Jersey, Maryland, and Missouri.

a. Varieties.—The many spinach varieties may be divided into three groups on the basis of type of foliage and character of seed. The three groups are: The savoy-leaved, round-seeded; the smooth-leaved, round-seeded; and the smooth-leaved, prickly-seeded. Practically all the important varieties grown for consumption in the fresh stage are included in the savoy-leaved group. This type stands shipment well; the plants are darker in color and do not pack closely together as those of the smooth-leaved groups do. They do not heat readily and are not inclined to wilt or turn yellow before reaching the consumer. Canning factories prefer the smooth-leaved group because they can be washed with greater ease in preparation for canning. The best of the savoy types, early or spring variety, is the Bloomsdale or Longstanding Bloomsdale; the late or fall variety is the Virginia Savoy. The best smooth-leaved varieties are Giant Nobel or the Giant Thick-leaved.

b. Harvesting and marketing.—(1) Spinach is harvested at a time when it will give a maximum yield of tender, succulent greens. If it is allowed to become old before being harvested, the quality is poor. The leaves should be cut before the development of seed stalks begins, since the presence of these stalks reduces the market quality of the spinach.

(2) The methods of packing spinach for market vary, the use of round-stave bushel baskets being most common. For long-distance shipment finely crushed ice is placed in each basket with the spinach.

c. Inspection and quality.—(1) Spinach for Army use should be of U. S. No. 1 grade and should comply with the requirements of the U. S. Standards for Grades of Spinach.

(2) Spinach of good quality has a fresh appearance, with crisp, clean leaves of green color.

(3) Spinach with yellow leaves, seed stems, or very coarse leaf stems may be tough and woody. Wilted spinach, or that which shows yellowing,

should be carefully examined for excessive disease or other injury. Decay in spinach may be present as soft, slimy rot.

d. Diseases.—(1) Mosaic or spinach blight is the most destructive disease of spinach. It appears first as a mottling of the young inner leaves, which later turn yellow and are finally killed. It gradually spreads to the outer leaves, which in turn change to yellow.

(2) Downy mildew or leaf mold is a disease that causes intermittent damage to spinach.

(3) Although the spinach aphid occasionally does considerable damage to spinach, damage by insects is on the whole rare. The spinach aphid sucks the juices from the plants and makes them unfit for marketing.

e. Suggestions for use.—Spinach can be prepared in many ways. Unlike other green vegetables, it can be cooked in a steamer without loss of color. If boiled, it should be cooked in a little water for not more than 10 minutes. It is palatable served hot with simmered beef, cold meats, fried liver and bacon, or hard-boiled eggs. If covered with a tart sauce, it is liked by most soldiers.

39. SQUASHES.—*a. Varieties.*—There are two types of varieties of squashes: The summer and the winter. They vary in color, size, and shape. Most of the white varieties of the summer type are disk-shaped and are known as simlins. The yellow varieties are generally long and crook-necked, and have a more or less rough rind, the roughness of the rind usually increasing with age. The green or green-striped varieties are usually cylindrical and are known on some markets as vegetable marrows or Italian vegetable marrow. Most of the winter-squash varieties have a dark-green or orange-colored rind, more or less coarse or rough. The most popular summer variety is the Bush Scallop. The common winter varieties are the Hubbard, Delicious, and Boston Marrow.

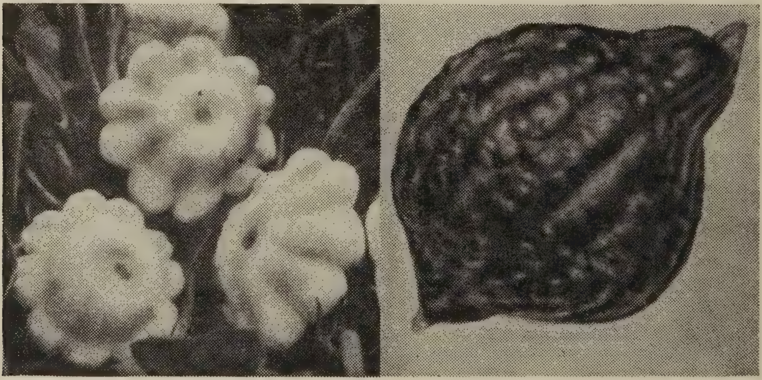


Figure 10.—Left, summer squash; right, winter squash.

b. Inspection.—(1) Summer squashes should be used while they are young and tender and the rind can be penetrated by the thumbnail.

(2) Hard-rind summer squashes usually have hard or semi-hard seeds, depending on the stage of development, and are therefore undesirable, since for most table uses the seeds and rinds are not discarded. The flesh or hard-rind summer squashes are also likely to be stringy. Winter squashes should have a hard rind and be free from blemishes. Soft-rind winter squashes are usually immature; the flesh may be thin, watery when cooked, and lacking in flavor.

(3) Squashes that are bruised or otherwise injured should be examined carefully for evidence of decay that may have penetrated them. Winter squashes are subject to decay, possibly because of handling and storage methods. Decay may appear as a watery or water-soaked area, sometimes covered with a moldlike growth, brown or black in color. The injured parts can sometimes be cut away without undue waste.

c. Suggestions for use.—As squash requires long cooking, it is best cooked in a steamer or pressure cooker. The Hubbard squashes, due to their hard shell, are usually baked in the shell. Summer squashes may be boiled or steamed and served as a vegetable with drawn butter or cream sauce; or they may be served mashed, or mashed and then fried. Winter squashes may be boiled or steamed and served mashed or in pieces; baked; or stewed and baked and made into pie. Squash pie has a flavor similar to that of pumpkin pie.

40. SWEET POTATOES.—*a. Varieties.*—Sweet potatoes vary in regard to the texture of the flesh—moist or dry; in regard to color—white or yellow; and in regard to shape—round or cylindrical.

(1) The commercially important varieties of the moist or semi-moist type are Nancy Hall, Puerto Rico, and Maryland Golden.

(2) The varieties of the dry type are Long Stem Jersey and Yellow Jersey.

b. Curing and storage.—(1) Prior to marketing, sweet potatoes are placed in storage houses for curing. The storage houses are so constituted that uniform temperature may be maintained, the influence of outside temperature reduced to a minimum, and ample ventilation and free circulation of air provided.

(2) The successful storage of sweet potatoes is dependent on three factors: careful handling during harvesting; thorough curing or drying as soon as they are placed in storage; and proper regulation of temperature and humidity during storage.

(3) When sweet potatoes are placed in storage they begin to lose moisture. This loss of moisture, or drying-out, is known as curing. During

this period a uniform temperature of 80° to 85° F., and a humidity of 85 to 90 percent insure uniform curing (see par. 69*b*). During the cure, ample ventilation, allowing free and continuous circulation of air around and through the bins, must be provided. When the curing is completed (2 weeks or longer) a lower temperature is necessary. The best storage temperature is 50° to 55° F. with a humidity of 80 to 85 percent (see par. 69*b*).

c. Inspection.—(1) Sweet potatoes for Army use should be of U. S. No. 1 grade and should comply with the requirements of the U. S. Standards for Grades for Sweet Potatoes.

(2) Sweet potatoes of good quality are clean, firm, smooth, and free from blemishes.

(3) Sweet potatoes that are shriveled, soft, and flabby are generally old, of poor flavor, wasteful, and may be diseased.

d. Suggestions for use.—Sweet potatoes are baked or boiled and served extensively in army messes. Sweet potato pie is popular in all messes.

41. TOMATOES.—Tomatoes are third in importance among the vegetable crops of the United States. Texas, Florida, and California produce the larger part of those grown for the commercial market.

a. Varieties.—Although there are many varieties, the more popular market varieties are the Marglobe, John Boer, Pritchard, Rutgers, and Baltimore.

b. Maturity and marketing.—(1) The stage of ripeness at which commercial tomatoes are harvested depends on the distance from the market. Those to be shipped long distances are picked when still green but mature enough to ripen properly after arriving at the market. Three definite stages of maturity are recognized commercially—mature green, pink, and ripe.

(a) Mature green tomatoes are difficult to judge correctly. Such distinguishing characteristics as glossy surface, whitish cast of skin, and a dark ring at the stem scar are of doubtful value. The jelly or gluelike material in the seed cells has sufficiently developed in mature green tomatoes to enable the fruit to be sliced without cutting the seeds. Mature green tomatoes are usually wrapped in paper and are sometimes called "green wraps." On arrival at commercial produce houses they are taken out of their paper wraps and inspected. Any that have ripened in transit are removed and repacked. The green ones are placed in special ripening rooms where the temperature is kept at 70° F. with a high humidity to prevent wilting or shriveling (see par. 70*b*). During ripening they take on a red color, and increase in moisture, acids, and sugars.

(b) Pink tomatoes are those which show a slight trace of pink or red color on the blossom end. They are usually not wrapped for shipment.

(c) Ripe tomatoes which are fully colored red or pink are shipped locally from areas near the market. They should be firm and show no indication of excessive softness.

(2) The container most commonly used for packing tomatoes is the lug box, which has almost wholly replaced the six-basket carrier and the four-basket flat. The lug box is packed in three layers and holds about 30 pounds net of tomatoes. The size of fruits is designated by the number of tomatoes each way, six by six, six by seven, and seven by seven being the commonest sizes. The tomatoes are wrapped each in tissue paper, which protects them against rubbing and abrasion and cushions the pack. Other types of containers used to market tomatoes are the Boston bushel box, the Jersey tomato crate, the New England half-bushel box, and the 8- or 12-quart braid veneer market baskets.

c. Inspection.—Tomatoes procured for Army use should be U. S. No. 1 grade conforming with the specifications for U. S. Standards for Grades for Tomatoes. They should be carefully examined and inspected for damage which may materially affect their appearance, edibility, and storage life.

d. Diseases and insect injury.—Although over thirty diseases affecting tomatoes are discussed in books and bulletins, most of them are only occasionally serious. The most troublesome of all is a fungus known as fusarium wilt, which causes wilting, yellowing, and finally death. Other diseases are leaf spot, late blight, and mosaic. Tomatoes are also attacked by various insects, the worst of which is probably the fruit worm. There are many diseases that affect tomatoes during shipment and storage and in ripening rooms, the more destructive of which are known as bacterial soft rot, rhizopus rot, ring rot, late blight rot, and soil rot. All cause decay. In addition, there are several serious injuries resulting from non-living agencies, such as freezing injury, blossom-end rot, growth cracks, puffiness, and sunscald.

(1) *Bacterial soft rot.*—The first symptoms of this rot are the development of depressed, water-soaked areas. In 3 to 10 days the entire fruit is converted into a soft, watery, colorless, foul-smelling mass. Green tomatoes are especially susceptible. At 59° F. about 17 days are required to rot them completely, while at about 86° F. only 7 days are required.

(2) *Rhizopus rot.*—This fungus produces a decay that is soft and watery and often of a fermentation odor. It does not grow at a low temperature of 35° to 40° F. but spreads rapidly at 70° to 80° F. It is one of the important diseases of ripe tomatoes. It rarely affects green fruit and is not found on the plant.

(3) *Blossom-end rot.*—This rot is due to a physical injury which seriously blemishes tomatoes and predisposes them to decay from other disease

organisms. In early stages the injury appears as small spots near the blossom end of tomatoes. As the spots increase in size the affected tissues collapse and become firm, leathery, and brown in color.

(4) *Freezing injury.*—Freezing injury of tomatoes results when the fruits have been subjected to 30° F. or below for several days. While in the frozen condition ripe and green tomatoes may appear glossy and candied, or dull-colored. On thawing, the tissues of the ripe fruit invariably break down and become watery; bacteria invade the tissues and cause foul-smelling decay.

(5) *Puffiness.*—Puffiness is one of the most important growth defects of tomatoes. Affected tomatoes are easily detected by their flattened sides, spongy texture, and light weight. When the pulp is cut, large air spaces are found in the cavities normally occupied by the seeds. Although no decay or discoloration takes place, the tomatoes are undesirable because of their angular appearance and poor slicing quality.

e. Suggestions for use.—Tomatoes should be served either sliced or cut, as salads, alone, or in combination with other vegetables. They may be stewed, or scalloped, or used as a base for soups, sauces, and dressings.

42. TURNIPS AND RUTABAGAS.—Turnips and rutabagas are among the most commonly grown and widely adapted root crops in the United States. Because of their similarity they are here discussed together. They are essentially cool-weather vegetables and are grown in the South during the fall, winter, and spring, and in the North during the spring and fall. Turnips resemble rutabagas in size of plant, in general size and shape of root, and in flesh colors. They differ chiefly in leaf characteristics and in minor details of root shape and structure. Turnip leaves are usually light green, thin, and hairy, whereas rutabaga leaves are bluish, thick, and smooth. Turnip roots generally have little or no neck and a distinct taproot, whereas rutabaga roots are often slightly more elongated and have a thick, leafy neck and roots arising from the under side as well as from the taproot.

a. Varieties.—The common varieties of turnips and rutabagas differ mainly in color and shape of root. Although there are both white-fleshed and yellow-fleshed varieties of each, most turnip varieties are white-fleshed whereas most rutabaga varieties are yellow-fleshed. Similarly, these varieties may have white, green, or purplish-red crowns. The most common white-fleshed varieties of turnips are Purple Top White Globe, Purple Top Strap Leaf, Purple Top White Milan, Extra Early White Milan, and White Egg. Shogoin, a white-skinned and white-fleshed Japanese variety with erect-growing, light gray-green strap leaves, is becoming more widely used each year in the South for greens or salads, as it is not damaged by aphids as much as the other varieties mentioned. The early season, white-fleshed varieties are most in favor in the South for the early spring market. The three most important yellow-fleshed varieties of turnips are Golden Ball or Orange Jelly, Amber or Yellow Globe, and Yellow Aberdeen. The variety Seven Top is grown in the South for use as greens, which are prepared for the table much like kale and spinach. The varieties of rutabagas commonly grown are American Purple Top, Monarch or Tankard, and Sweet Perfection White.

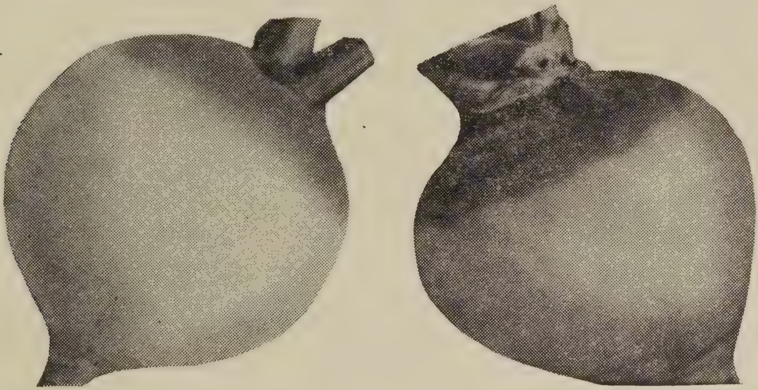


Figure 11.—Left, purple-top turnip; right, rutabaga.

b. Inspection.—(1) Turnips or rutabagas for Army use shall be of U. S. No. 1 grade and shall comply with the requirements of the U. S. Standards for Grades for Turnips and Rutabagas.

(2) The condition of the tops of bunched turnips is an indication of quality. The tops should be fresh, green, young, and turgid.

(3) Yellowed or wilted tops of bunched turnips may indicate damage of some kind, possibly caused by long keeping. The turnips may be soft or shriveled. When in this condition they are undesirable, as they may be tough when cooked. Large, coarse, overgrown turnips, especially those that are light in weight for their size, may be tough, pithy, hollow, or strong in flavor.

c. Suggestions for use.—Turnips and rutabagas may be boiled and served with drawn butter or cream sauce; boiled and mashed; or cut or sliced and cooked in stews or with roasts. The addition of a little browned bacon to them adds to the flavor.

STORAGE OF FRESH VEGETABLES

43. ARTICHOKES.—Jerusalem artichokes, if held in storage at a temperature of from 31° to 32° F. in a relative humidity of 90 to 95 percent, may be expected to remain in good condition 2 to 5 months. At a low humidity they shrivel badly and are more likely to decay than if kept at a medium humidity. They are sometimes stored in barrels or in paper-lined, airtight bags, in which they seem to keep longer, with less wilting and decay. They keep better if left with long stems.

44. ASPARAGUS.—Fresh asparagus is stored only when the market is overstocked. Experiments have shown, however, that it can be kept successfully for 3 to 4 weeks at a temperature of 32° F. (see par. 9). At this temperature, growth of the stalks, which takes place at a higher temperature, is practically stopped. The original tenderness of fresh asparagus is soon lost at ordinary storeroom temperature, owing to the formation of woody tissue, but may be preserved at the lower temperature. Furthermore, the sugar content, to which asparagus owes some of its flavor, after cutting rapidly diminishes at higher temperatures but remains practically the same if the asparagus is put in storage immediately. Therefore, the sooner asparagus is placed in proper storage after harvesting, the better will be its condition when used. The loss of water while in storage or transit is likely to be great if the stalks are not stood on wet moss or other moist absorbent material placed in the bottoms of the crates. In storage, asparagus bunches are sometimes set in water in shallow trays or pans. After a long haul to market, asparagus should not be expected to keep in storage for more than 3 to 6 days.

45. BEANS, GREEN OR SNAP.—Green beans are usually stored for only short periods. When held at 32° F. they may be expected to keep 3 or 4 weeks provided they are in good condition and are placed in storage promptly. To prevent wilting, the humidity should not be lower than 85 percent, and the hampers or other containers should be stacked as to allow abundant air circulation. If the containers are packed close together the temperature may rise somewhat because of the heat given off by the beans, and more or less rapid decay may be expected. If the beans are stored too long, the pods may become moldy or slimy. They should be free from surface moisture when stored and should be kept from a contact with ice.

46. BEANS, LIMA (FRESH).—Shelled lima beans are sometimes stored in quart baskets and, if fresh and sound when stored, can be expected

to keep in good salable condition for about 15 days at 32° F. and about 4 days at 40° F. If stored too long, they tend to fade to a light color and become sticky. Unshelled lima beans can be held satisfactorily for 3 to 4 weeks at 32° F. and 10 days at 40° F. (See par. 12.)

47. BEETS.—Late beets will keep satisfactorily for 1 to 3 months if stored at 32° F., with a relative humidity of 95 to 98 percent for topped beets and 85 to 90 percent for bunch beets. Beets are subject to wilting because of rapid loss of water and should be kept where the humidity is sufficiently high to prevent excessive evaporation. Before being placed in storage they should be topped and well sorted to remove all those diseased and those showing physical injury. They are best stored in ventilated barrels or slat crates. Storage in large bulk should be avoided. Bunch beets may be stored at 32° F. for 10 days to 2 weeks. The tops retain a fairly fresh appearance if they are not crowded in storage. If beets are to be held for 1 or 2 days, the crates or containers should be opened and the beets loosened to allow air to circulate among them; otherwise heating will take place and the leaves will become discolored and undesirable. Leaves will discolor more rapidly if kept warm and wet than if kept cool and dry.

48. BROCCOLI.—Since Italian sprouting broccoli does not keep well in storage, it is usually held for only very short periods, at an optimum temperature of 32° F. If in good condition and stored with sufficient ventilation between the packages, it should keep satisfactorily for 10 days. Longer storage is undesirable because the leaves are likely to discolor and the buds may drop off.

49. BRUSSELS SPROUTS.—Brussels sprouts are stored only occasionally but require the same conditions as described for broccoli. They should be held in small containers to prevent yellowing and development of mold. The maximum storage period is 3 to 4 weeks under an optimum temperature of 32° to 35° F., with a relative humidity of 90 to 95 percent.

50. CABBAGE.—*a.* A large percentage of the late crop of cabbage is stored to be sold during the winter and early spring, or until the new crop from the Southern States appears on the market. If stored under proper conditions, cabbage should keep from 3 to 4 months. It can be most successfully held in common storage in the Northern States—New York, Pennsylvania, Michigan, and Wisconsin, chiefly—where a fairly even inside temperature of from 32° to 35° F. can be maintained. Cabbage in quantity is usually not held in cold storage, because its value does not

justify the expense of handling. The longest-keeping qualities belong to the Danish Ballhead class.

b. Storehouses should be insulated sufficiently to prevent freezing, for although slight freezing does no harm, hard freezing is liable to cause considerable loss. More ventilating capacity than is required for most other vegetables should be provided for cabbage in order to carry away the excessive moisture given off by the active respiration and to obtain the maximum advantage of the cold night air during mild winter. Cabbage wilts quickly if held under too dry storage conditions; hence the humidity should be high enough to keep the leaves fresh and turgid. Bin storage is common, the bins being usually 4 to 5 feet wide, 10 to even 20 feet long, and about 5 feet deep. They are best separated by slat partitions with 4-inch air spaces between slats. Tiers of bins may be built as high as it is convenient to elevate the cabbage. The use of slat shelves with the cabbage piled one or two layers deep is considered the best method, but is too expensive when large quantities of cabbage are to be stored.

c. Cabbage should be handled carefully from the field to the storage. Before it is stored, the roots and all loose leaves should be trimmed away, and the damaged and misshapen heads should be culled out. On being removed from storage, the heads should be trimmed again to remove loose and damaged leaves.

51. CARROTS.—*a.* Carrots are stored in fairly large quantities in early winter, and their marketing period extends to late winter or early spring, when the new crop from the South appears on the market in competitive quantities. They are usually held in common storage in those regions where the storage temperature can be kept sufficiently low. They are sometimes held in cold storage, although the prices obtained for them do not usually justify this kind of treatment.

b. It is generally considered that carrots can withstand very light freezing without injury, but that they should be protected from severe freezing. They are best stored at a temperature of 32° F. They are subject to wilting or drying out if the humidity is not fairly high; for this reason they are more easily kept in a well-ventilated cellar or bank storage. The relative humidity should be maintained at 90 to 95 percent.

c. Before being placed in storage, carrots should be topped and all misshapen or injured ones sorted out. The latter are especially objectionable because their presence in a storage lot favors the development of two serious diseases: namely, watery soft rot and bacterial soft rot. Carrots are best kept in slat crates or ventilated barrels, and allowance should be made for air circulation between containers. Bunch carrots may be stored for 10 days to 2 weeks; during this period the tops will still retain a fresh appearance if they are free from surface moisture and not crowded in storage.

52. CAULIFLOWER.—Cauliflower is not usually kept in cold storage; however, it can be stored for 2 or 3 weeks satisfactorily if a temperature of 32° F. is maintained. Successful storage depends not only on preventing decay but also on retarding the maturing of the head or curd. Overmaturity is marked by a browning of the otherwise white curd and the development of a ricey appearance. The leaves also become yellowish and may drop off. Freezing causes a grayish-brown discoloration and softening of the curd, accompanied by a water-soaked condition.

53. CELERY.—*a.* Much of the late celery crop is placed in cold storage and held for several weeks before marketing. Considerable celery from Florida and California is put in storage toward the end of the production seasons in order to lengthen the marketing period. Celery is most successfully kept at a temperature of 31° to 32° F. with a relative humidity of 90 to 95 percent. Wilted celery can sometimes be revived by standing the stalks in a pan of ice cold water for a few hours.

b. Celery is a rather perishable vegetable and is particularly subject to watery soft rot if not kept at the temperature indicated. It should be examined carefully for this disease before being placed in storage. It should be brought from the field into storage as soon as possible after harvesting in order to prevent heating.

c. Crates should be stacked with 2- by 2-inch strips between the crates, and 2-inch air spaces between the stacks. There should be at least 2 feet of air space between the top of the stacks and the ceiling. All this precaution is to allow air circulation between and around the crates to aid the removal of heat that is generated by the celery. Under proper storage conditions celery should keep 2 to 4 months in good marketable condition.

54. CORN (SWEET).—*a.* Corn is seldom stored, although there are occasions during the southern shipping season when it may be desirable to put an excess supply temporarily in cold storage. However, storage for more than a few days may result in loss of flavor. The sugar content which so largely determines the quality of corn rapidly decreases if stored at ordinary temperature. In order to keep this loss of sugar to a minimum and preserve the flavor, corn in the shuck as it comes from the field for consumption in the fresh state should be cooled to about 32° F. as quickly as possible.

b. Corn should not be handled in bulk, because of its tendency to heat, but put into baskets or crates which allow air circulation, in order to remove field heat and heat produced by respiration. In the condition in which it usually arrives on the market it should not be expected to keep satisfactorily in cold storage for more than 4 to 8 days.

55. CUCUMBERS.—Cucumbers are usually held in storage for periods not exceeding 10 to 14 days, with storage temperatures of 45° to 50° F., and with a relative humidity of about 85 percent. When they are held for longer periods than recommended at 45° or below, dark-colored watery areas, which are an indication of low temperature injury, appear. These areas soon become infected, and mold growth develops. If cucumbers are held at 50°, little or no breakdown develops within 4 or 5 weeks, but they tend to ripen, the color changing from green to yellow.

56. EGGPLANTS.—Eggplants are usually not stored for long periods, because they are subject to physiological breakdown marked by watery spots and decay. However, they can be held for 7 to 10 days under an optimum storage temperature of 45° to 50° F., with a relative humidity of 80 to 85 percent.

57. ENDIVE OR ESCAROLE.—Endive or escarole as commercially handled is not adapted to long storage. Even at 32° F., which is considered to be the best storage temperature, it cannot be expected to keep satisfactorily for more than 2 or 3 weeks. The storage requirements for endive are practically the same as for lettuce. Like lettuce, endive should keep somewhat longer than the period just mentioned if it is stored with cracked ice in or around the packages. The relative humidity in rooms where it is held should be kept at 90 to 95 percent in order to prevent wilting. A certain amount of desirable blanching usually occurs in endive held in storage.

58. GARLIC.—Garlic is best stored under the temperature and humidity conditions required for onions. If in good condition and well cured when stored, it should keep at 32° F. for 6 to 8 months. In central California, where considerable garlic is grown, it is freqently put in common storage, where it may be held for 3 to 4 months, or sometimes longer, if the building can be kept cool, dry, and well-ventilated. Garlic is stored in loose mesh bags piled two layers deep in stacks separated by air spaces. It must be well cured in the field before going into storage.

59. LEEKS.—Green leeks are crated and stored under conditions similar to those suitable for celery. If properly handled, they should keep satisfactorily for 1 to 3 months in storage.

60. LETTUCE.—*a.* Lettuce is sometimes put in cold storage when there is a surplus on the market, or in certain sections when the fall crop

is threatened by approaching cold weather. If in good condition when stored, it can be expected to keep for 2 to 3 weeks. There is some evidence that it can be kept in better condition if ice is placed in the packages at the time of storage.

b. One of the most troublesome diseases of lettuce in transit and storage is tipburn of the type that develops in the interior of the head. This injury appears in the field, but in the later stages of the marketing process it is frequently followed by a slimy bacterial decay which may result in serious damage. Frequent inspection of stored lots is desirable.

61. PARSNIPS.—Parsnips have nearly the same storage requirements as carrots and should keep for 2 to 4 months. They are not injured by slight freezing while in storage but should be protected from hard freezing and very carefully handled while in a frozen condition. Since they dry out quickly in storage, the humidity of the storage place must be kept relatively high. They are sometimes stored in sand or clean soil to prevent wilting, but they keep in good condition when held in barrels or crates if the proper humidity is maintained.

62. PEAS.—Much the same storage conditions are required for peas as for beans. Shortly after being picked, peas tend to lose part of their sugar content on which much of their flavor depends. They cannot be expected to keep in salable condition for more than 1 to 3 weeks unless packed in crushed ice, in which condition the storage period may be extended perhaps a week. They keep better unshelled than shelled.

63. PEPPERS.—*a.* Chili peppers are usually picked when ripe and then dried and allowed to equalize in moisture content in covered piles. Water is usually added to them after drying, and as a result they become less brittle. They are then packed tightly in sacks holding 200 to 300 pounds and stored in warehouses for a period often lasting 6 to 9 months. The temperature of the warehouses depends to some extent on their construction and the way in which they are managed but chiefly on the outside temperature. In southern California, where a large part of the commercial crop of chili peppers is produced, the outside temperature ranges from 50° to 80° F. during the usual storage period.

b. The moisture content of chili peppers when stored is generally low enough (20 to 15 percent) to prevent mold growth; the chief problem in storage is insect infestation. Some manufacturers of chili pepper products hold part of their supply of peppers in cold storage if necessary, but they prefer to grind them as soon as possible and store them in the manufactured form in airtight containers. Sweet or bullnose peppers, if in good condition, may be easily kept fresh in storage for a month to 6 weeks at a temperature of 32° F. A humidity of 85 to 90 percent is desirable to prevent shrinkage.

64. PUMPKINS.—In general, most varieties of pumpkins will not keep in storage as long as the usual storage varieties of squashes. Such varieties as Connecticut Field and Cushaw are relatively poor keepers and cannot be expected to keep in good condition more than 2 or 3 months. Varieties like Large Cheese and Table Queen keep 3 to 6 months. Pumpkins should be well matured, carefully handled, and free from injury or decay when put in storage. The best storage temperature seems to be from 50° to 55° F., with a humidity of about 70 to 75 percent. Investigations have shown that a preliminary curing at 80° to 85° F. for about 2 weeks is of benefit in ripening immature pumpkins and in healing physical injuries incident to harvesting.

65. RADISHES.—Winter radishes require the same storage conditions as carrots and should keep in good condition for 2 to 4 months. (See par. 51.)

66. RHUBARB.—Rhubarb stalks, if fresh and in good condition, may be stored for 2 to 3 weeks. They should be bunched and packed in crates and stacked to allow ample air circulation on all sides; otherwise there is danger of heating and mold growth.

67. SPINACH.—Spinach is usually stored for only short periods. It should keep fairly well for a week or two after being cut. If crushed ice is used in the packages, the storage period can be extended somewhat.

68. SQUASHES.—*a.* Squashes should be covered with vines to prevent freezing and left in the field 2 or 3 weeks to ripen and harden the shells. They should then be stored. They should be cut off the vines leaving the stem attached to them. The truck carrying them should be lined with burlap or hay to avoid bruises. They must be handled carefully; broken stems and bruised skins are sure to cause decay.

b. Squashes should be stored in a warm, fairly dry place. A temperature ranging from 42° to 48° F. is ideal, with a relative humidity of 70 to 75 percent. The storage house, as a rule, is built with a wooden floor and bins with shelves. Squashes are never piled on each other and should not touch each other on the shelves, as one rotting squash will infect another one. Disinfecting the storage house by spraying with a 1-200 formalin solution or some other disinfectant before putting the squashes in storage helps to prevent rotting, and dipping them momentarily in a solution made up of 1 pint of formalin and 25 gallons of water will kill the germs on them. However, it is useless to disinfect them unless the storage room has also been disinfected. Provisions must be made for heating the storage room in winter, as the temperature must be kept above 40° F.

69. SWEET POTATOES.—*a.* When freshly dug potatoes are to be stored for any length of time they should be given a preliminary curing treatment to permit the healing of all wounds or abrasions incident to harvesting and handling, in order to prevent the entrance of decay organisms.

b. The curing and storing are done in the same house; so the potatoes do not have to be moved after the curing treatment. When commercial lots are handled, the storage house is generally of special construction with sufficient insulation to maintain a uniform temperature and with some means of ventilation that will insure the desired humidity. Provision should be made for heating the building during the curing process and for holding the proper storage temperature afterward. The curing process ordinarily takes from 10 to 14 days, during which period the house is kept at a temperature of 80° to 85° F., with a relative humidity of 85 to 90 percent (see par. 40*b*). After the curing period the storage temperature is allowed to drop to from 50° to 55° F., with a humidity of 80 to 85 percent (see par. 40*b*). Short periods of a few hours at a temperature somewhat lower than 50° F. need not cause damage, but prolonged periods of low temperature should be avoided because of the danger from certain types of decay which are more likely to develop at a temperature below the range given.

c. Only well-matured potatoes that are practically free from physical injury or decay should be stored. Potatoes are usually stored in slat crates of about a bushel capacity or in bushel baskets; however, shallow bins are sometimes used. They should be handled as little as possible during storage.

70. TOMATOES.—*a.* Ripe tomatoes are held in storage only temporarily and should not be stored at a temperature lower than 40° F. At 40° to 50° F., if not already soft ripe, they will keep in good condition for a week to 10 days. At a temperature lower than this they sometimes show a tendency to deteriorate.

b. Green tomatoes are best kept at a temperature not lower than 55° F. At this temperature they ripen slowly but satisfactorily; mature green tomatoes can be kept for 1 to 6 weeks before becoming overripe. At a temperature below 55° F. green tomatoes do not ripen well; if they are kept below 55° F. more than 5 to 8 days and then moved to a warmer place, they do not usually ripen satisfactorily. Exposure up to 5 to 8 days to a temperature of 40° F. or even somewhat less does not usually prevent mature green tomatoes from ripening satisfactorily, when later removed to a favorable temperature. If fairly rapid ripening is desired, a temperature from 60° to 70° F. should be used (see par. 41*b*). At

70° F. or above, ripening is accelerated, but so also is the development of decay, which is difficult to control. The relative humidity of tomato storage or ripening rooms should be from 80 to 85 percent.

71. TURNIPS AND RUTABAGAS.—The best type of winter storage to use depends on the severity of winter climate and the quantity of turnips and rutabagas to be stored. For storage of large quantities in mild climates, out-of-door pits or piles are satisfactory. In severe climates and for storage of small lots, indoor or specially constructed storage is recommended. For cellar storage, crates or small piles laid on a dirt floor are satisfactory. Small quantities of turnips may be stored in a cool cellar covered with moistened, clean sand to keep them fresh. The storage temperature in a cellar or in a cold-storage room should remain between 32° and 35° F., with a relative humidity of 90 to 95 percent. Dry furnace-heated cellars with concrete floors are not satisfactory for storage.

TABLE IV
STORAGE CONDITIONS OF FRESH VEGETABLES

Vegetable	Storage temperature (degrees F.)	Relative humidity (percent)	Storage life	Freezing point (degrees F.)
Artichokes	31-32	90-95	2-5 months	27.5
Asparagus	32	85-90	3-4 weeks	29.8
Beans, green	32-40	85-90	2-4 weeks	29.7
Beans, lima	32-40	85-90	2-4 weeks	30.1
Beets, bunch	32	95-98	10-14 days	......
Beets, topped	32-35	95-98	1-3 months	26.9
Broccoli	32-35	90-95	7-10 days	29.2
Brussels sprouts	32-35	90-95	3-4 weeks	......
Cabbage	32	90-95	3-4 months	31.2
Carrots, bunch	32	85-90	10-14 days	......
Carrots, topped	32	95-98	4-5 months	29.6
Cauliflower	32	85-90	2-3 weeks	30.1
Celery	31-32	90-95	2-4 months	29.7
Corn, sweet	31-32	85-90	1-3 weeks	29.0
Cucumbers	45-50	80-85	10-14 days	30.5
Eggplant	45-50	85-90	10 days	30.4
Endive	32	90-95	2-3 weeks	30.9
Garlic	32	70-75	6-8 months	25.4
Horseradish	32	95-98	10-12 months	26.4
Kohlrabi	32	95-98	2-4 weeks	30.0
Leeks	32	90-95	1-3 months	29.2
Lettuce	32	90-95	2-3 weeks	31.2
Mushrooms	32-35	80-85	2-3 days	30.2
Parsnips	32	90-95	2-4 months	28.9
Peas, green	32	85-90	1-2 weeks	30.0
Peppers, sweet	32	85-90	4-6 weeks	30.1
Pumpkins	50-55	70-75	2-6 months	30.2
Radishes (winter)	32	95-98	2-4 months	......
Rhubarb	32	90-95	2-3 weeks	28.4
Spinach	32	90-95	10-14 days	30.3
Squashes (winter)	50-55	70-75	2-6 months	29.3
Sweet potatoes	55-60	75-80	4-6 months	28.4
Tomatoes, green	55-70	85-90	3-5 weeks	30.4
Tomatoes, ripe	40-50	85-90	7-10 days	30.4
Turnips	32	95-98	4-5 months	30.5

CHAPTER TWO

DEHYDRATED VEGETABLES

SECTION I

INTRODUCTION

72. DEVELOPMENT.—*a. General.*—The dislocation and destruction of normal transportation channels, and the primary importance of feeding armed forces regularly and well, have focused attention, for nearly a century, upon dehydrated foods in war emergencies. Desiccated foods were used in the Civil War, especially to minimize the incidence of scurvy. During the Boer War similar products were used. World War I stimulated the production of millions of pounds of dehydrated vegetables, as shown by the following table of shipments during that period.

Potatoes, White	6,437,430	pounds
Onions	336,780	"
Carrots	214,724	"
Turnips	56,224	"
Soup Mixture	1,860,000	"

Lack of information regarding the basic principles of dehydration resulted in tasteless, tough, dehydrated products. Following World War I, the industry lapsed into a state of inactivity.

b. World War II.—(1) Demands of the past war revived the dehydrated food industry. Although the dehydrated items of past world crises have been vitamin deficient and lacked acceptable appearance and palatability, improved technology, which has reduced drying and processing time, has resulted in a very superior product.

(2) In 1942, the Quartermaster Corps purchased considerable quantities of dehydrated white potatoes, cabbages, onions, and carrots, with some beets, sweet potatoes, and rutabagas. Potatoes constituted more than 50 percent of the total. Most of the 1942 output came from California, Washington, Idaho, and Oregon, where many fruit dehydrators were available for conversion into vegetable dehydrators, or where, as in Idaho, much excellent raw material (potatoes) could be procured.

(3) During the 1943 and 1944 seasons, over a hundred dehydration plants were in operation producing dehydrated apples, beets, cabbage, carrots, cranberries, hominy, onions, white potatoes, rutabagas, and sweet potatoes.

73. OBJECTIVES IN DEHYDRATION.—In general, the Army objectives concerning dehydration are as follows:

- *a*. Dehydrated vegetables must rehydrate well upon soaking for the shortest practical time. The pieces must absorb water and return to their original size, form, and appearance to the greatest degree possible.
- *b*. The dehydrated vegetables must cook until tender without disintegrating or becoming mushy.
- *c*. Dehydrated vegetables must retain much of their original flavor and color.
- *d*. Dehydrated vegetables must be sufficiently dry so that they will not deteriorate in storage for long periods at extreme temperatures.
- *e*. Dehydrated vegetables must retain a considerable portion of their original vitamin and mineral contents.
- *f*. Dehydrated vegetables must be provided with packaging containers which will prevent contamination by insects and absorption of moisture.

SECTION II

PRINCIPLES OF DEHYDRATION

74. QUALITY FACTORS.—Success in drying depends upon the observance of a few fundamental principles, and the quality of the finished product depends upon the care exercised in the selection of the raw materials, upon proper preparation for drying, upon careful control of the temperature, and upon the particular type of equipment used.

75. METHODS.—Vegetables may be dried by the following methods:

a. Air
b. Superheated steam
c. Vacuum
d. Inert gases
e. Direct application of heat

Each method has its own particular advantages and disadvantages and the process used is governed by the type and quality of the product to be dried.

76. AIR.—Air has two main functions in drying: it conveys heat to the product, and it carries moisture away from it. The amount of hot air needed to dehydrate or evaporate a given product varies with the amount of moisture present. For example, if the product contains 75 percent moisture before drying, it will be necessary to evaporate 3 pounds of water for each pound of dry product, but if the moisture content is 95 percent, it will be necessary to evaporate 19 pounds of water for each resultant pound of dry product.

77. RELATIVE HUMIDITY.—*a.* Relative humidity is the percentage of saturation of air with moisture vapor at the given temperature. The saturation point is 100 percent. At 25 percent relative humidity, the air contains one-fourth as much moisture as at 100 percent.

b. The higher the temperature of air, the greater its moisture carrying power. Therefore, raising the temperature decreases the relative humidity, and lowering the temperature increases the relative humidity. Thus at 180° F. and 90 percent relative humidity, one pound of air contains about 0.57 pounds of moisture; whereas at 130° F. and 90 percent relative humidity, it contains only about .095 pounds of moisture.

c. Relative humidities are determined by means of two thermometers, one having its bulb dry, and the other its bulb closely covered by a silk or muslin gauze kept moist with distilled water. The two thermometers are placed in the air stream and are read when they have reached constant temperature. The accompanying chart (fig. 12) may be used for determining relative humidity directly.

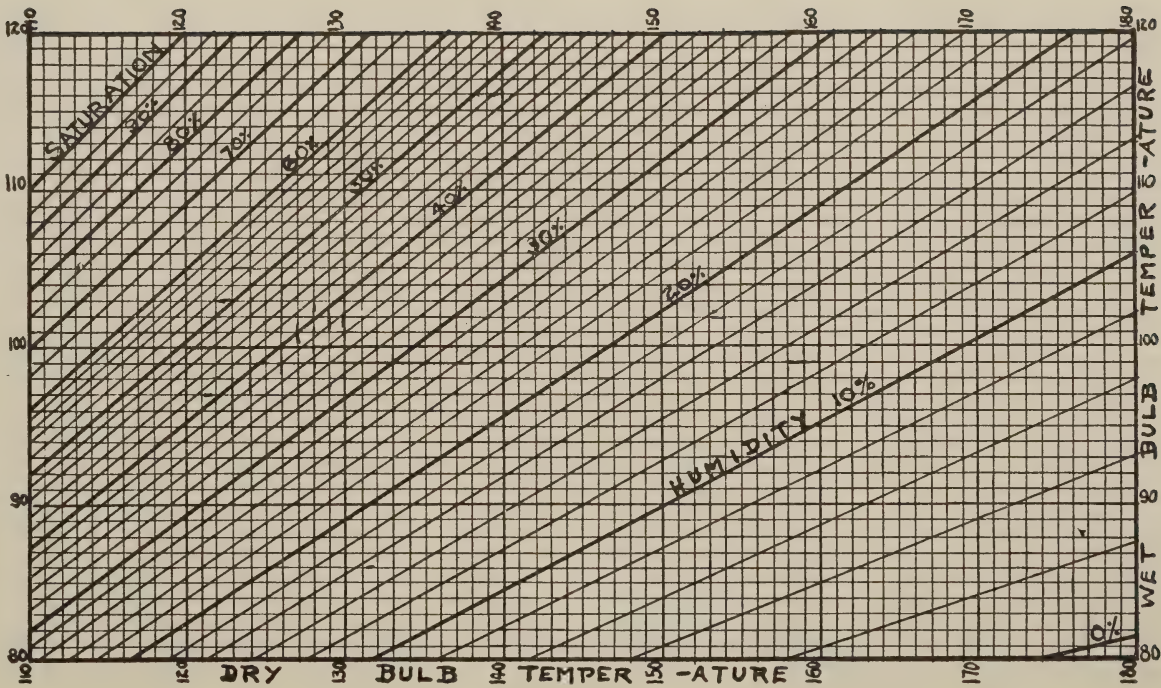


Figure 12.—Humidity chart. In this chart to find the relative humidity follow the cross-section line corresponding to the dry-bulb temperature until it intersects the cross-section line corresponding to the wet-bulb temperature observed. From the relation of this point to the diagonal lines the relative humidity may be read. For example, at a dry-bulb temperature of 150° F., and a wet-bulb temperature of 110° F., the relative humidity is 28 percent. Before taking readings be sure that the wet bulb is exposed to a high velocity of air and that the wick is clean; moisten only with distilled water. (Chart drawn by G. B. Ridley.)

d. Only distilled or rain water should be used to fill the reservoir that moistens the wick on the wet-bulb thermometer. The reason for this is that tap water contains salts. As the water is evaporated, there would be a steady accumulation of these salts on the wick. This would lessen the rate at which the water is evaporated, the wet-bulb thermometer would give too high a reading, and the humidities calculated from such values would be in error.

78. AIR VELOCITY.—The velocity is also a function of the air volume and greatly affects its drying capacity. For drying vegetables the velocity across the trays should be not less than 500 linear feet per minute. The evaporation of water from a free surface is directly proportional to the velocity of the air, other things being equal.

TABLE I

EFFECT OF VELOCITY ON DRYING TIME

Velocity Feet per minute	Drying time	
	Carrots	Cabbage
(Ft./min)	(Hours)	(Hours)
250	5.3	5.5
500	4.0	4.0
750	3.5	3.5
1,000	3.0	3.2

79. TEMPERATURE.—*a. Case-hardening.*—If the temperature is not properly regulated the vegetables may become case-hardened—that is, develop a tough hard and sometimes glassy layer at the surface, making it difficult to remove moisture from the center of each piece. Sweet potatoes cut in thick pieces may also case-harden, but other vegetables of low starch content usually do not exhibit this phenomenon to a serious degree. Case-hardening is less evident at high than at low relative humidity. In the dehydration of all vegetables, however, very low relative humidity should be used in the final stages of drying.

b. Critical temperature.—(1) When the moisture content has dropped to a low value near the end of the drying period, the moisture no longer comes to the surface in sufficient amount to maintain rapid evaporation. Consequently, the product rises in temperature and attains practically the dry bulb temperature during the last stage of drying. At that time the sugars, starches, and other constituents have been highly concentrated and are, thereby, made more susceptible to injury by heat. The temperature at which the product is seriously injured is spoken of as the critical temperature. The critical temperature for each vegetable varies according to the condition of the material being dehydrated.

(2) Above their critical temperature, blanched potatoes develop a reddish color and a disagreeable flavor; other vegetables darken in color and are injured in flavor.

80. KEEPING QUALITY REQUIREMENTS.—If vegetables are to keep in good condition for a year or more, they must be dehydrated carefully, have a low moisture content, and be protected from moisture uptake and insects.

SECTION III

TYPES OF DEHYDRATORS

81. GENERAL.—There are many forms of commercial driers in use today, but dehydration of foods is accomplished in the following ways:

a. Batch or compartment
b. Tunnel
c. Spray and rotary
d. Drum
e. Vacuum (used in few instances)

82. BATCH OR COMPARTMENT DEHYDRATORS.—Batch dehydrators consist of a drying chamber having forced or natural draft circulation and holding trucks with stacks of trays.

a. Forced draft circulation.—Heated air is diverted to each chamber from a main duct and circulated in a vertical direction through the tiers of trays. The air is passed from the chamber into a recirculation duct to be either reheated or discharged from the dehydrator.

b. Natural draft circulation.—(1) The air beneath the drying compartment is warmed and then, being lighter than the adjacent unheated air, rises through or across the trays. The heat carried to the product by the air causes evaporation, and the moisture-laden air escapes from a ventilator.

(2) It is difficult to control the temperature closely in the drying chamber. Furthermore, these driers are inefficient in their use of heat; drying is apt to be slow and uneven. They are usually less costly to build than the forced-draft dehydrators.

(3) A common natural-draft drier is a tower or stack evaporator. Several trays rest on runways, one over the other, above the furnace and heating pipes. The freshly loaded tray, entering on the topmost runway, is transferred downward periodically each time a tray of the finished product is removed from the lowermost runway.

(4) Though the natural-draft driers are inefficient and wasteful of fuel, besides being high in labor cost, they will serve for vegetables if operated carefully and intelligently. In out-of-the-way localities or frontier regions, where power for a fan is lacking, they could be used to advantage. It is difficult, however, to secure a high grade, uniform product with the desired low moisture content.

83. TUNNEL DEHYDRATORS.—*a. General.*—(1) Most of the dehydrators used for vegetables in the West are of this type. Generally it consists of a tunnel about 6½ feet wide by about 7 feet high in cross-section and about 50 to 60 feet long. Cars of trays, the latter usually 6 x 3 feet in

size, loaded with the freshly prepared raw product, enter the cooler, meet moist air at the exhaust end of the tunnel, and are moved forward progressively toward the hotter, drier end, where drying is completed.

(2) There is an air-heating device, usually a furnace of firebrick in which natural gas or fuel oil heats the incoming air, or a steel furnace shell with radiating pipes. A large fan circulates the air through the furnace and across the trays. Beside, above, or below the drying tunnel is a second tunnel or large duct, which contains another furnace and fan and through which any desired proportion of the air used in the drying tunnel may be returned to the heating chamber and used again in drying. Customarily one fan, one furnace, and one air-return duct serve two drying tunnels. The cars move on steel rails or castor wheels on the concrete floor of the tunnel and preparation room.

(3) The average tunnel holds about 10 tons of prunes or 5 tons of vegetables, since the loading with vegetables is about half that used for prunes. Some operators, however, use only 40 feet or less of the tunnel, in order to secure maximum drying rate.

b. Parallel-current tunnel and truck dehydrators.—(1) The parallel-current tunnel is identical in design with the counter-current, the only difference lying in the method of operation. In the parallel-current method the fresh product enters the hot-air end of the tunnel, where the maximum temperature exists; and then it travels progressively toward the cool, moist, exhaust end. Drying is completed in moist, relatively cool air.

(2) During the first hour or two the drying proceeds very rapidly because the product is moist and quickly gives up its moisture, and because the hot air is at or near its maximum drying capacity. As the product approaches the exhaust end the increasing humidity and decreasing temperature markedly retard the drying. In fact, a parallel-current tunnel of the commercial size usually cannot reduce the moisture content below the maximum allowed in Army specifications. For this reason the parallel-current tunnel is generally used only for the first stage of dehydrating vegetables, the second or finishing stage being conducted in a second tunnel or compartment operated on the counter-current principle.

c. Two-stage tunnel dehydration.—(1) The two stage procedure, combining parallel and counter current, has been followed in operating several commercial tunnel dehydrators. It is used in one of two manners: In one case, two tunnels are used; and two-thirds or more of the moisture is removed from the apples or vegetables in a parallel-current tunnel whose initial temperature may be 190° F. or higher. The drying is then completed in a second tunnel operated on the counter-current principle, finishing at 135° F. to 150° F. In the other case, a single tunnel is used; but it is equipped with a movable partition, so placed that the first section of the tunnel is shorter (usually by one-half) than the second. The loaded trucks of fresh product enter the first section and travel parallel current. The truck, on reaching the movable partition, is transferred to the second compartment, where its progress is counter current.

(2) Usually two fans and two air heaters are employed. Part of the spent air from both compartments is exhausted from the center of the tunnel, and part of the air is recirculated. This two-stage tunnel is also known as a center-exhaust tunnel dehydrator. Extremely rapid drying occurs in the parallel-current tunnel or section; in the second or counter-current tunnel or section the moisture content can be reduced to the desired point. Over-all drying time is much shorter than in the counter-current tunnel. See figure 13 for the floor plan of a two-stage, center-exhaust dehydrator.

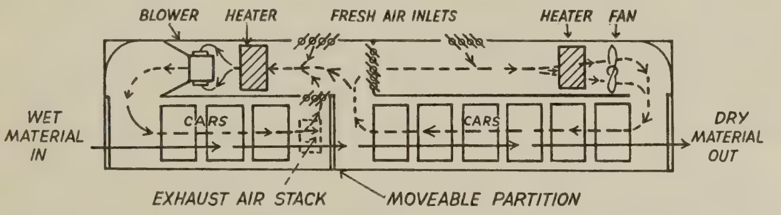


Figure 13.—Floor plan of a forced-draft, recirculation, center-exhaust, two-stage-tunnel dehydrator. (After W. B. Van Arsdel.)

84. SPRAY DRIERS.—*a.* In spray drying, the fluid product is atomized under high pressure through a fine nozzle or by a rapidly revolving centrifugal atomizing disk into a violently whirling blast of heated air in a circular chamber. The droplets, drying almost instantaneously, fall to the bottom of the drying chamber, or are floated by air current into dust collectors or bag filters. The resultant powder is packed at once, in air-tight containers.

b. This drier is in general use for powdered milk and eggs. It is used commercially for soups and juices. Vegetable purees other than tomato must be broken to colloidal-sized particles by a colloid mill or "disintegrator" before spray drying.

85. ROTARY DRIERS.—*a.* In this type, the material is fed in at one end of a rotating cylinder, revolving about a lengthwise axis. It is automatically conveyed through the cylinder either in parallel flow or in counter-current flow. The heated air may also enter the cylinder throughout its length from openings (louvres) in the inner wall of the double-walled cylinder. In other heating systems, steam pipes extend lengthwise of the

cylinder; or the inner surface of the cylinder is heated by a steam jacket.

b. Inasmuch as it tumbles the product violently, this drier is not suitable for most vegetables. It is successful with precooked beef, alfalfa hay, apple pomace, grape seeds, and other firm, easily dried materials.

86. ATMOSPHERIC DRUM DRIERS.—*a.* The liquid, puree, or slurry is spread on the surface of a steam-heated revolving stainless-steel drum about 8 feet in diameter, and 12 to 14 feet in length. The thickness of the film, the degree to which it has previously been concentrated, and the rate of rotation are so adjusted that, by the time the product has rotated to a certain position, the material is dried and is scraped off by a knife extending the length of the drum. The dried food leaves the drum in a continuous sheet, is cooled, and made friable by a current of dried cold air. Broken into flakes, it is conducted from the drying room by a screw conveyor and is then packed at once in airtight containers to prevent moisture uptake with consequent caking. The drier may have one drum, or the liquid may be spread between two.

b. Drum driers are used successfully for tomato soups, tomato cocktail, and cranberry sauce; for whey, buttermilk, and skim milk dried for stock feed. They should be successful with vegetable purees.

87. VACUUM DEHYDRATORS.—*a.* Dehydration in vacuum offers two advantages—namely, low drying temperatures and the absence of air. The disadvantages are the expensive and complex equipment, the difficulty in transmitting heat to the product, the small output per $100 of plant investment, and the danger of scorching in the attempt to hasten drying.

b. Vacuum driers are of several types. In the shelf drier, the raw material is spread on hollow metal shelves in a steel chamber, which can be sealed and subjected to high vacuum. The heating medium (steam, hot water, or hot oil) is circulated through the hollow shelves, and heat reaches the product through the metal walls of the shelves. Recently infra-red rays have been proposed as a source of heat in vacuum driers. In an alternative method, electricity can be used to heat the product through the metal trays resting on resistance-metal grids. There is no appreciable air circulation. The water vapor travels to a water-cooled condenser, where it is condensed and removed by pump, or by barometric water-spray condenser and overflow from a barometric leg.

c. The vacuum drier is more useful for reducing partially dried fruits and vegetables to a low moisture content than for drying raw materials of high moisture content. Apple nuggets are prepared in this manner.

88. AUXILIARY DRYING BINS.—*a.* Toward the end of the dehydration period, vegetables lose their moisture very slowly and are more

susceptible to heat injury. In order, therefore, to increase the output and to control quality and final moisture content more closely, some operators now remove certain vegetables from the dehydrator at the "leathery" stage and place them in bins, through which a current of very dry air of 110° to 125° F. is passed until the moisture content reaches the desired low level. The use of finishing bins greatly increases the output, permits closer control of final moisture content, and reduces danger of heat injury.

b. In moist weather the air may have to be dried artificially, as by silica gel, calcium oxide, or refrigeration. Normally, however, the drying rate is adequate at 120° to 125° F. without such treatment. The bin can be rectangular, with wooden walls. Its screen bottom is connected to the hot-air duct.

TRAYS

89. DESCRIPTION.—*a. Dimensions.*—The usual wooden tray (fig. 14) is made up of the following pieces: for the bottom, 20 to 23 pieces 1⅜ x ⅜ inches x 6 feet; each end of 1 piece, 1⅜ x 1⅞ inches x 3 feet and 1 piece 1¼ x 1⅛ inches x 3 feet; each side of 1 piece 1¼ x ½ inches x 6 feet; and for center cross strips, one piece 1¼ x 1⅞ inches x 3 feet.

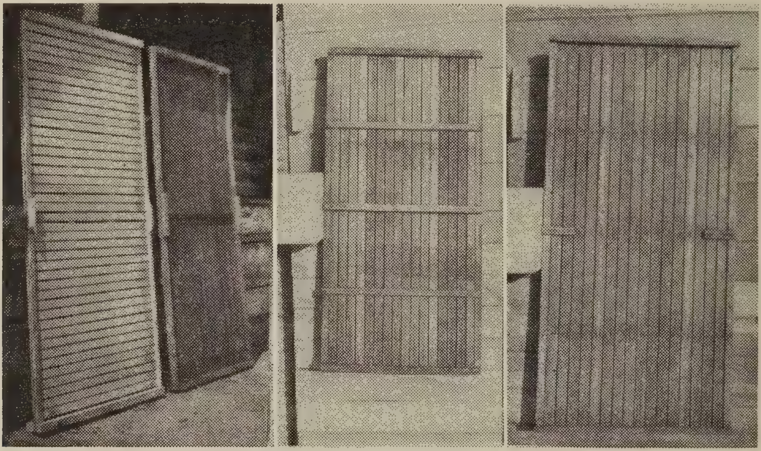


Figure 14.—Types of 6x3 foot wooden trays. At the left is shown a tray with crosswise slats and one with solid bottom. The two at the right are top and bottom of a tray built of lengthwise slats; the bottom side has the cross cleats.

b. Construction.—Since most tunnel dehydrators used for fruits are equipped with slat-bottom wooden trays measuring 6 x 3 feet and with trucks designed for this size of tray, those producers using fruit tunnels for dehydrating vegetables have adopted the slat tray. The ends are higher than the sides, giving a space between trays of about 2 inches, permitting the air to flow across the shorter (3-foot) diameter of the trays. Lengthwise flow has been found to result in very uneven drying. The wood used should not be resinous or pitchy, should not impart disagreeable flavors, nor should it stain the vegetables. The preference is for Oregon pine (Douglas-fir).

90. PRECAUTIONS IN USE.—*a. Splinters.*—Great care should be exercised to prevent inclusion of wood splinters in the final product where wood slat trays or trays with wooden frames are used.

b. Sagging.—With continued use 6 x 3 foot trays will sag near the middle causing "bunching" of the product and uneven air distribution with resultant uneven drying. The center of the tray, therefore, should be reinforced with a suitable cross strip; and the bottom center cross strip of one tray should rest upon the top cross strip of the next.

c. Sticking.—Vegetables frequently have a tendency to adhere to the tray. To minimize sticking, the trays may be coated with tasteless mineral oil or wax. Various commercial wax compounds which have proved to be more satisfactory than mineral oil are in general use. Observations readily show that the cleaner the tray, the less sticking will take place. Galvanized wire mesh trays have proved satisfactory for some products. Trays made entirely of metal are more expensive, but are more satisfactory in durability, in ease in cleaning, in minimizing sticking, and in eliminating the presence of splinters in the finished product.

SECTION V

HEAT SOURCES

91. NATURAL GAS.—Natural gas is an ideal fuel for dehydration. It is inexpensive, clean burning, high in heat content, and easily regulated. Where it is employed, the products of combustion are mixed with the air used in drying so that most of the heat generated enters the dehydrators.

92. SPECIAL FUEL OILS.—Many dehydrators also use special fuel oils, such as stove distillate, and special burners that give complete enough combustion to permit the combustion products to be mixed with the air used in drying. Crude oil is apt to burn less completely and to impart off odors and flavors.

93. COAL.—Where coal is used as fuel, heat is generally applied indirectly. The products of combustion pass through flues, and air heated by passing over these flues is applied to the product; an alternate method, seldom used, is to generate steam and heat the air by passing over steam radiators.

94. ELECTRICITY.—Electricity may be used to heat metallic grids, which in turn heat the air. Except for experimental use, the cost is excessive.

SECTION VI

FACTORS AFFECTING THE GRADE OF DEHYDRATED VEGETABLES

95. GENERAL.—An acceptable dehydrated vegetable should be prepared from fresh, sound, properly matured vegetables and should be preprocessed and dehydrated as soon as possible after harvesting (except for products which are ordinarily stored for a reasonable length of time before use, e.g., white potatoes, sweet potatoes, beets). A dehydrated product should be attractive in appearance, of good aroma, color, and texture. It should retain much of its nutritive value, and should rehydrate easily to its original color, flavor, texture, and shape. Without exception, a dehydrated product should possess as low a moisture content as is commercially feasible to maintain the factors mentioned for a period of at least 12 months.

96. VARIETY.—Variety is one of the most important factors affecting the grade of the dehydrated vegetable. A suitable variety should afford a minimum of bruising, decay, and loss of "freshness" on handling and transportation. It should be tender and flavorful, have an attractive appearance, good nutritive value, and should not result in undue changes in quality during dehydration. It should also give a profitable yield.

a. Beets.—Beets for dehydration should be globular or top-shaped, deep red, and relatively free from zoning (white bands in the flesh). The Detroit Dark Red is a common globular variety.

b. Cabbage.—The Savoy, a green-leafed open-head cabbage, has resulted in a satisfactory dehydrated product. However, it is a light producer and many dehydrators prefer the solid-head varieties. Some varieties develop a stale odor and flavor in drying, and others become yellowish. Since cabbage requires a cool climate, it is a late fall and winter crop in many sections, as in the San Joaquin, Imperial, and Sacramento valleys of California. It can be grown as a summer crop in cool coastal regions.

c. Carrots.—In a comparison of ten carrot varieties, the Imperator, Red Core Chantenay, Danvers, Half Long, Morse Bunching, and Nantes gave very good results, the first two being preferred. The color of most other varieties was too light at the core, or less intense than the Imperator and Chantenay. Commercially, the Imperator and Chantenay are about equally regarded. At present, these are the most important varieties for dehydration in California.

d. Onions.—Onion varieties vary materially in yield per acre, drying ratio, sugar content, pungency, and color. Pungent varieties of light color are preferred by the Army. Of the pungent onions, the Ebenezer is among the best for dehydration though less common in California than some other varieties of lower pungency such as the Southport White Globe and Bermuda. The White Creole, another pungent variety of good drying quality, is found primarily in the Southern States.

e. Sweet potatoes.—The Porto Rican variety or moist type is the best variety for dehydration. Maryland Golden and Nancy Hale are also dehydrated to a large extent. The Porto Rican produces a uniform deep yellow-pink color, and possesses a desirable flavor. Sweet potato production is greatest in the Southern States.

f. White potatoes.—Preference is given to those varieties that are mealy after cooking. Comparing ten varieties of potatoes, the Netted Gem (also known as Klamath Russet, Idaho Russet, Oregon Gem, and Russet Burbank) was rated highest in quality after drying. Irish Cobbler, Triumph, Katahdin, Sebago, and Chippewa are a few of the varieties commonly dehydrated.

97. HANDLING THE FRESH PRODUCT.—*a. Quality requirements.*—The fresh product should be of good quality, properly matured, and free from damage such as growth cracks, bruising, sunburn, storage damage, insect infestation, mold, or obvious evidence of decay. If the product is not to be processed field-fresh, it should be properly stored in rooms screened off, fumigated, or otherwise protected from insects, with proper humidity, temperature, and ventilation. For example, potatoes which have been stored in cellars at low temperatures (35-40° F.) must be conditioned (i.e., allowed to return gradually to approximately room temperature) in warm storage (70° F.) for a variable length of time, 10 days to 3 weeks, to prevent the development of a red-brown discoloration in the dry product during storage and to reduce the sensitivity of the potato to heat damage "scorching." Potatoes which have been exposed to light, or the sun, either in the field or after harvesting, become sunburned and develop a greenish color in the tissues. Sunburn in dehydrated potatoes is evidenced by a translucent greenish yellow color. The greenish color often develops a bitter taste which renders the potato unpalatable.

b. Enzymes.—Enzymes are normal constituents of living cells, and are necessary for the breakdown of chemical substances to give the plant energy, and for the utilization of that energy for plant growth and life. When a product is dehydrated, it does not lose all its potentialities for the production of energy or growth. Many of the more resistant enzymes (some peroxidases and catalases) remain, as well as the chemical substances which they can affect. If these enzymes are not destroyed or inactivated, chemical changes will occur, resulting in the accumulation of certain substances in sufficient amounts to injure the product, causing toughening or discoloration, hay-like odors, or off-flavors.

98. SANITATION.—Sanitation should be observed throughout the entire plant, and the greatest care should be observed in handling the dried product after removal from the dehydrator to prevent contamination and insect infestation.

SECTION VII

PREPARATION OF VEGETABLES FOR DRYING

99. GENERAL.—*a.* The production of dehydrated vegetables is a seasonal operation under normal conditions. The starting date varies in different parts of the country in accordance with the maturity dates of the crops.

b. The principal operations in the preparation of vegetables for drying are:

(1) Washing
(2) Sorting
(3) Trimming
(4) Peeling (roots and tubers only)
(5) Subdividing
(6) Blanching
(7) Traying
(8) Dehydrating
(9) Packaging

The accompanying flow sheet describes the sequence for dehydration.

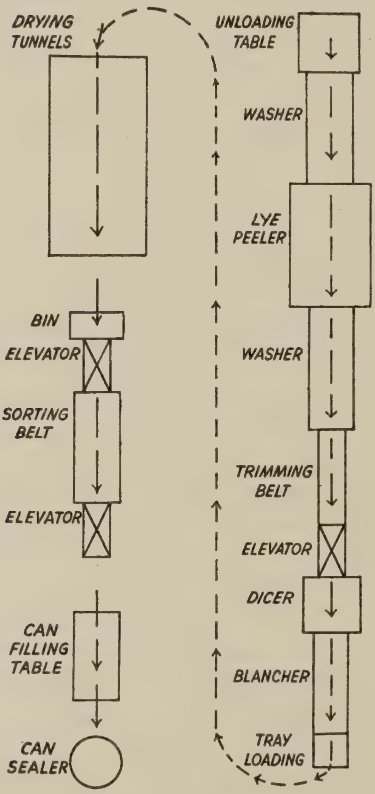
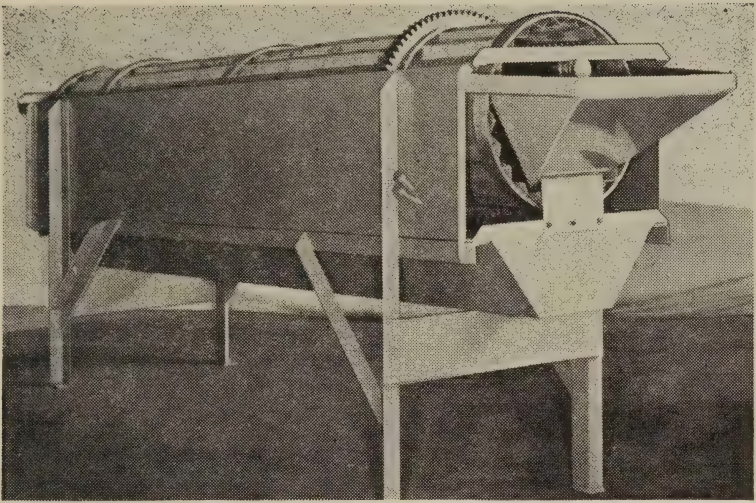


Figure 15.—Flow sheet for dehydration of carrots.

100. WASHING.—Vegetables should be thoroughly washed before peeling or blanching to sufficiently clean the product. Standard equipment and methods of washing vegetables for canning are commonly used in washing vegetables for dehydration. For most vegetables, the vigorous agitation and scrubbing given by a rotary washer (fig. 16) is best. This washer consists of a revolving, perforated, galvanized sheet-metal drum fitted with spray nozzles near the central axis which supply forceful streams of water under high pressure and in ample volume. Rotation of the washer rubs the vegetables against each other, loosening the adhering soil.

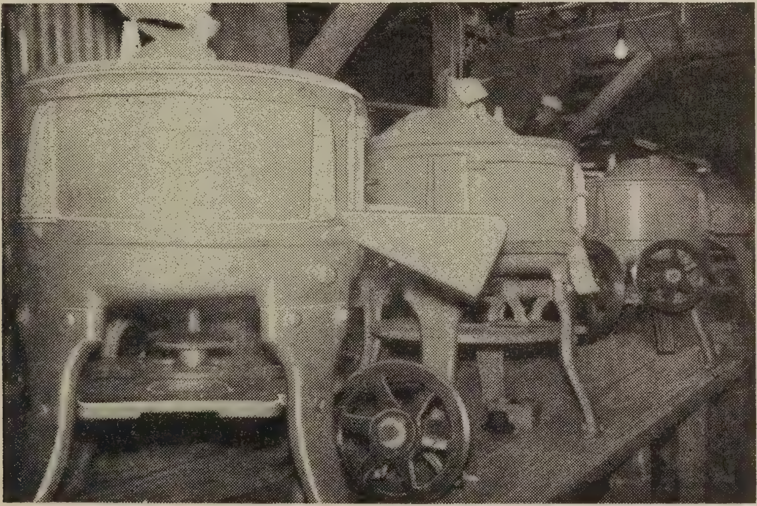


COURTESY FOOD MACHINERY CORPORATION

Figure 16.—A corrugated rotary drum washer.

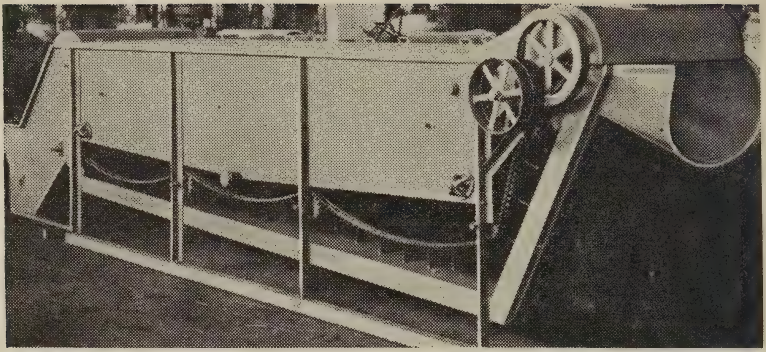
101. SORTING.—Vegetables are generally sorted after washing and before peeling and trimming to remove obviously defective pieces, such as those caused by rot, wilting, mechanical damage, and other sources.

102. PEELING.—Root vegetables and tubers must be peeled before dehydration. Three methods are in commercial use: (1) abrasion, (2) immersion in boiling lye solution, and (3) steam pressure peeling. Peelers are shown in figures 17 and 18.



COURTESY FARM CREDIT ADMINISTRATION

Figure 17.—Battery of abrasion peelers for potatoes and root vegetables.



COURTESY FOOD MACHINERY CORPORATION

Figure 18.—Draper-type lye-peeler.

a. Abrasion peeling.—The abrasion peeler is an upright, metal cylinder. The inner surfaces of the walls and bottom are covered with coarse carborundum crystals or similar abrasive material, tightly cemented to the metal. The bottom is rotated rapidly and the skins of the potatoes are rasped off. Sprays of water wash away the gratings of peel. When the operator judges that peeling is completed, the vegetables are removed through a side door. The peeler is operated on either a batch or continuous basis. The chief disadvantage to abrasion peeling is the high loss of solids. For potatoes, the loss usually exceeds 25 percent.

b. Lye peeling.—Lye peeling is commonly used for most root vegetables and tubers. The peeling operation consists in mechanically agitating and conveying the vegetables through a tank of boiling lye solution. For carrots about 3 percent sodium hydroxide is satisfactory; for potatoes and sweet potatoes 10 to 15 percent. Rinsing after lye-peeling is done in a rotating drum spray washer.

c. Steam pressure peeling.—In steam pressure peeling, the vegetables are deposited into a closed drum which can be rotated on its long axis. After closing the "batch," steam is admitted under 70 to 80 pounds pressure, the drum rotated for 5 minutes, and the steam pressure is then released abruptly. The potatoes on removal are washed under high pressure water sprays, and the peeled product then goes to the trimming table. Steam peeling may be a batch or continuous process. A comparison of peeling methods has shown the steam peeling method to be the most efficient and economical to operate.

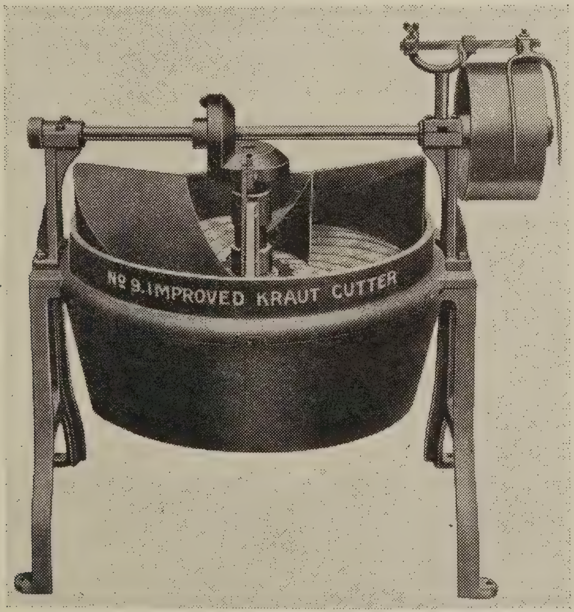
103. TRIMMING.—Vegetables require considerable sorting and trimming by hand, after peeling, to remove defects, such as growth cracks, eyes, rot, bruises, and storage shrivel, which may not be removed in the peeling operation. This sorting and trimming is usually carried out on a moving

belt with a center portion divided off from the incoming vegetables. The sound, sorted, and trimmed vegetables are placed on the center portion which conveys the product on to the next process.

104. SEGMENTING.—After other preparation treatments are completed, vegetables must be reduced to a convenient size for dehydration. This is accomplished either by cutting or by complete maceration and extrusion into a new form.

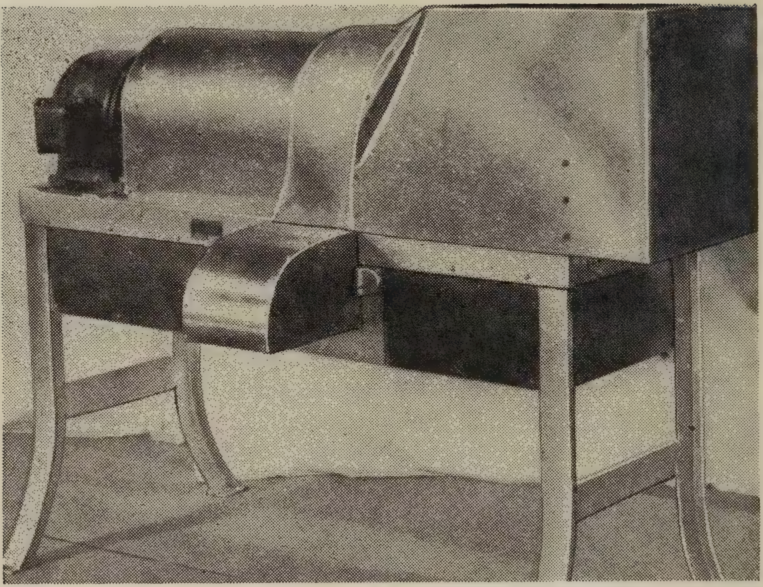
a. Cutting.—Following the trimming process, the vegetables are cut into slices, dice, or strips. Onions and cabbage are sliced or shredded (see fig. 19). Tubers and root vegetables are usually diced or cut into strips; the Urschel slicer (fig. 20) is generally used.

b. Potato Granules.—During the war a dehydrated product termed "riced" was produced for making mashed potatoes; after peeling and cooking, the potatoes were extruded into spaghetti-like strings. An improved dehydrated mashed potato has been termed "granules." Potatoes are peeled, trimmed, sliced, pre-cooked, and cooled before being frozen. After freezing they are thawed and riced, then dehydrated to about 50 percent of their moisture content. The partially dried potatoes are then granulated by being rubbed through a vegetable pulping machine. The granulated particles are finally dried to 6 percent moisture.



COURTESY FOOD MACHINERY CORPORATION

Figure 19.—Sauerkraut cutter for shredding cabbage.



COURTESY FOOD MACHINERY CORPORATION

Figure 20.—Urschel dicing and strip-cutting machine.

105. SULFITING.—*a. Effect on storage life.*—Considerable storage data available indicate that the application of sulfite treatment to vegetables prior to dehydration results in increased storage life for the product. Several methods have been devised for applying the sulfite solution. Most operators use a spray treatment when the material is approximately one-third of the distance through the blancher. Dipping procedures have also been used satisfactorily.

b. Absorption.—The absorption of sulfite is dependent upon the material, the size of the individual units, the concentration and temperature of the applied solution, and the duration and method of the treatment. The blanching and drying operations effect the retention of the sulfite in the finished product.

c. Effect on taste.—The "pickup" of sulfur dioxide from the products of combustion in direct oil fired tunnels should not be confused with a sulfite treatment. Products of combustion may impart flavors other than sulfur dioxide to the product, causing the reconstituted material to have a very disagreeable taste. In the quantities used the added sulfur dioxide has no adverse effect on the flavor of the product.

106. BLANCHING.—*a. General.*—In the early days of dehydration, blanching was omitted. Consequently, the dried products were tough,

oxidized and darkened in color, and leafy products were hay-like or disagreeable in odor and flavor. Even on prolonged cooking they remained tough or fibrous.

b. Purpose.—Blanching, which is generally conducted in live steam, has two main purposes: inactivation of enzymes by heat, and precooking of the product. Proper blanching inactivates the enzymes responsible for undesirable changes in color, odor, and texture, and for the loss of vitamins during drying and subsequent storage. The precooking allows the dehydrated vegetable to rehydrate rapidly and cook quickly.

c. Exceptions.—Onions and garlic are exceptions to the rule that all products should be blanched, because the volatile oils responsible for their characteristic odor and flavor are lost during blanching, leaving a flat, tasteless product.

d. Methods.—Blanching in hot water is less desirable than blanching in steam because the water dissolves a considerable proportion of the vitamins, minerals, sugars, and other food substances. There are several methods of steam blanching. The vegetables may be passed on a woven conveyor or belt through a horizontal steam box with the blanched hot vegetable dropping onto trays at the outlet end. Cabbage and other leafy vegetables which are extremely difficult to handle after blanching are blanched on trays. Slat-bottom wooden trays, or metal trays made of galvanized wire mesh or other type metal are used. The product is spread on the trays and the tray passed through the blancher. The cabinet type blancher is merely a cabinet which is equipped with steam inlets and holds a truck load of trayed material per batch.

e. Degree of blanch.—Under-blanching does not give the desired results, while over-blanching makes the product "mushy" and hard to dry. The rate of flow of the product through the blancher, the temperature, and the steam pressure used are very important. Most operators periodically test the enzymatic activity of the material as it leaves the blancher, so that adjustments in the amount of blanching can be made to compensate for variations which occur in the raw material. It has been found that such factors as maturity, sugar content, freshness, variety, growing conditions, etc., determine, to a large degree, the conditions under which individual lots of raw material must be prepared and dehydrated to give an acceptable finished product.

107. TRAYING.—Prepared vegetables are spread evenly on suitable trays and the amount of loading is particularly important. The general practice of overloading trays to increase the capacity of the dehydrator is inefficient. Heavy loading of trays retards the air flow through the raw product, resulting in longer drying time and consequent loss of quality

and yield. Careful study has shown that loads of ¾ to 1½ pounds per square foot may be used, the lighter loads for leafy vegetables and the heavier loads for most root vegetables.

108. DEHYDRATING.—*a. General.*—(1) The time required to dry vegetables in a tunnel type hot-air dehydrator and the daily drying capacity of the same dehydrator are inseparably related, so that any change which affects the one will affect the other. Considerations of quality favor rapid drying. Conditions which bring about rapid drying, other things being equal, also will increase the drying capacity of the dehydrator; but paradoxically, a reduction in the drying load imposed on the unit may be the only feasible method of shortening the drying time.

(2) The factors which determine the practical drying time are:

(a) design of dehydrator
(b) volume of air-flow
(c) maximum safe temperature
(d) proportion of recirculation of air
(e) rate of input of wet product (that is, dehydrator capacity)
(f) weight or depth of moist product carried by unit of the trays
(g) character of the product dried.

b. Design of dehydrator.—(1) In general, rapid drying is favored by a dehydrator which assures intimate contact of the rapidly moving drying air with the product, and eliminates useless short-circuiting of air.

(2) Rapid drying at reasonable capacity is favored by moving the air through the tunnel in the opposite direction to the flow of the product (counter-current), or introducing hot air at both ends of the tunnel and exhausting the cool, moist air near the center.

(3) Rapid drying is favored by insulating the tunnel against loss of heat, and by eliminating air leakage.

(4) Rapid drying is favored by moving the air at high velocity over the moist product. This velocity should be at least 800 linear feet per minute, and it may with advantage be 1,000 or even 1,200 linear feet per minute, at least in the wet end of the tunnel. After one-half to two-thirds of the moisture has been removed from the material, air velocity has little effect on the rate of drying.

(5) Rapid drying is favored by the use of drying trays with metallic perforated or mesh bottoms, which transfer heat by conduction to the moist material; and by using any arrangement which causes a part or all of the drying air to pass through the layer of moist material.

c. Volume of air-flow.—Entirely separate from the effect referred to above, a high total volume of air-flow favors the combination of rapid drying with high drying capacity.

d. Maximum safe temperature.—Rapid drying is favored if the incoming air is heated to the highest temperature that is safe to use on the product in question. This allowable air temperature is generally somewhat higher for the moist product than for the dried, because the moist product stays relatively cool while its moisture is evaporating rapidly.

e. Recirculation of air.—(1) If a part of the air exhausted from the cool end of a tunnel is returned, mixed with the incoming fresh air, and reheated, the air in the tunnel becomes more moist; drying time becomes longer, but a substantial saving of heat results.

(2) A high percentage of recirculation is common in fruit drying tunnels, partly to prevent the occurrence of "case-hardening," a condition which develops when dehydration is attempted at too high a temperature and too low a relative humidity. This phenomenon is rarely experienced in the dehydration of blanched vegetable slices, strips, and cubes of the usual dimensions and recirculation becomes almost entirely a matter of compromise between heat economy and tunnel capacity or drying time.

Note: Factors 2, 3, and 4—Volume of air-flow, temperature, and proportion of recirculation—taken together, determine the theoretical maximum drying capacity of the dehydrator. Actual drying performance must always be less than this theoretical maximum, and may be only a small fraction of it.

f. Capacity.—(1) Optimum drying rates may be realized in a tunnel dehydrator only by operating the equipment in such a manner that the air passing through the tunnel does not cool perceptibly, and is low in relative humidity throughout the tunnel. These conditions can be attained in ordinary tunnel dehydrators only by diminishing materially the weight of moisture evaporated into the given volume of circulating air—that is, by diminishing the evaporative load on the tunnel. The evaporative load may only be decreased by diminishing the weight of moist product charged into the tunnel per hour—either by decreasing the load of product per square foot of tray surface while decreasing in a smaller proportion the length of time a single truck is held in the tunnel, or if the tray loading is maintained unchanged, by diminishing the number of trucks in the tunnel at one time. The latter method, carried to the limit, leaves only a single truck, and the product is dried as a batch. Such a unit is known as a cabinet dehydrator. If a cabinet dehydrator is operated in this way to attain maximum drying rate, the cost of heat is excessive, while if measures are taken to conserve heat—for example, by recirculation—drying time lengthens toward that normally required in a tunnel.

(2) It should be noted that if the air-flow must be interrupted whenever a fresh truck is put into the tunnel, drying substantially stops in all

the trucks while the tunnel remains open. If this changing of trucks takes place at short intervals of time, the equipment loses a perceptible part of its rated drying capacity. For example, if effective drying stops for 2 minutes out of every 15, drying capacity is almost 10 percent less than if the shut down is for only 2 minutes out of every 45. The length of time trucks must be held in the tunnel increases proportionally. The improvement in drying time which may be expected to result from light tray loading, therefore, is partly offset by this factor of increased shut-down time.

g. Tray loads.—(1) Rapid drying is favored by relatively light tray loading. Drying rate is affected but little as the loading increases up to a fairly well defined critical load, but above that point it is substantially slower.

(2) Rapid drying is favored by careful attention to uniformity of loading on the trays. Localized heavy loadings will delay the completion of drying of an entire truck. A few small wet spots remaining on a tray as a result of uneven loading, if not picked out, will remoisten a much larger quantity of dry product and render it worthless.

Note: The main advantage of a reasonably long tunnel, in vegetable dehydration, is that it allows trays to be loaded lightly, thus helping to increase the rate of drying, without unduly decreasing the capacity of the tunnel. Too long a tunnel, on the other hand, is difficult to control, and is expensive to build, maintain, and operate. Practical commercial tunnels compromise between the extremes, range from 30 to 55 feet long over-all; the actual length occupied by trucks is usually between 20 and 40 feet.

h. Character of prepared material.—(1) Regardless of the amount of air and heat furnished, if the moisture is difficult to remove because of physical structure, high sugar content, or other reasons, the drying cannot be rapid or the drying capacity high. Experimental determination of drying rate under known conditions is the only way to evaluate the effect of these differences.

(2) Pieces of thin cross-section dry more rapidly than thick ones.

(3) Pieces which give a porous layer on the tray—potato or cabbage shreds, or strongly curling carrot slices—dry faster than pieces which adhere into a single thick layer, like non-curling potato slices.

(4) "Mush" caused by bruising, careless handling, or over-blanching dries very slowly.

i. Boiler horsepower required.—Where neither natural gas nor fuel oil are available as a source of heat for dehydration, it will be necessary to use steam. The boiler horsepower required for this will vary according to the capacity of the plant. Very roughly, however, large (30-35 tons of fresh, prepared product per 24 hours) plants will require from 6 to 10 boiler horsepower of steam-generating capacity for each ton of vegetables to be dried per 24 hours. For smaller installations, more boiler horsepower will be required per unit of production.

j. Practical considerations.—Commercial dehydration makes practical compromises between many of the foregoing factors. Local conditions will affect the relative importance given to one or the other. The actual drying time, even for the most easily dehydrated products is rarely less than 4 hours and is usually 5 to 6 hours. Drying times of 6 to 8 hours are frequently encountered in practice. A time as long as 12 hours is unnecessary for any common vegetable, in slices, shreds, or cubes of the usual dimensions, if the final moisture content need not be reduced much below 5 to 7 percent. The shorter the drying time for a given product, in general, the higher will be the dehydration cost per pound of product for heat, power, and some elements of labor, but if the short drying time is accompanied by increased plant output fixed charges per pound of product will usually decrease, partly or wholly offsetting the higher operating cost.

PACKAGING

109. CONTAINERS.—Dehydrated vegetables must be packed in suitable containers which are moistureproof, moisture-vapor-proof, and insect-proof. Precautions should be taken that the product is not insect-infested before being put in the containers. For best results, the packaging should be done in a room with low relative humidity, free from dust, and separate from the operating part of the plant. Five-gallon tin cans which are hermetically sealed are ordinarily used as containers for dehydrated vegetables. Two 5-gallon cans of dehydrated vegetables are packed together in a wooden box for shipping. The following figures represent the average amounts of dehydrated vegetables packed in 5-gallon cans:

Vegetable	*Julienne*	*Dice*	*Rice*	*Flakes*
Beets	15-16 lbs.	15-21 lbs.	—	—
Cabbage	—	—	—	7-15 lbs.*
Carrots	—	17-20 lbs.	—	—
Onions	—	—	—	12½-16 lbs.*
Rutabagas	—	20-21 lbs.	—	—
Sweet Potatoes	—	19-23 lbs.	—	—
White Potatoes	14-16 lbs.	14-18 lbs.	12-15 lbs.	—

*Wide range due to introduction of in-can compression.

110. GAS PACKING.—Army specifications require that certain dehydrated vegetables (carrots and cabbage) must be packed under an inert gas, such as carbon dioxide or nitrogen. Efficient gas packing reduces the oxygen level of the 5-gallon container to 2 percent or less. Gas packing is effective in retarding bleaching of color and deterioration of flavor in the product.

SECTION IX

REHYDRATION

111. GENERAL.—Rehydration is the absorption of water by previously dehydrated vegetables. It is not possible in every case to reproduce with exactness the original moisture content of the fresh food. As yet it has not been possible to rehydrate a product to 100 percent of its original moisture content. For example, fresh raw cabbage contains 89 percent water before dehydration; after rehydration it may contain only 83 to 85 percent water. The amount of water that the food will absorb depends upon factors involved in the dehydration and rehydration of the product. *The quantity of water which a dehydrated food will absorb is variable.* It is wise to keep this fact in mind when using specific recipes or formulas for rehydration. Since it is impossible to eliminate small discrepancies in such formulas, a cook must use the recipe plus his own common sense.

112. CHARACTER OF DEHYDRATED PRODUCT.—The vegetable used for dehydration is the first factor—that is, the degree of maturity, the climatic conditions during the growing season, and the variety of the plant are all factors which contribute to the variability of rehydration results. Methods used for blanching might affect subsequent rehydration efficiency. Many factors involved in the process of dehydration may influence the rehydration of the product. The temperature, air velocity, and humidity of dehydration must be carefully controlled if good results are to be obtained upon rehydration. For example, if certain foods are dried too rapidly, they form almost impervious shells or skins around the outer surface and are said to be case-hardened. Such products do not rehydrate satisfactorily.

113. REHYDRATION METHODS.—The method of rehydration is perhaps one of the most important factors to be considered in the use of dehydrated food. This is the factor over which the cook working with this food has complete control. If the correct procedure is followed, satisfactory results will be obtained. If not, he will have an inferior finished product. The following general method of rehydration is designed to have a maximum absorption of water within a limited length of time.

a. Water-vegetable ratio.—The first step in the process of rehydration is the careful measurement of both the water and the vegetable. This is very important because an insufficient quantity of water will not permit the vegetable to absorb the maximum amount of moisture, and the finished product will be of very poor texture. Too much water will result in a loss of nutritive value through the necessity of pouring off the surplus. A good rule to follow is "Keep the water to a minimum but never skimp." Hot water should never be used unless the recipe calls for it—the water should be either cool or lukewarm. The dehydrated vegetable then is carefully measured into the previously measured water. All the measurements should be level.

b. Soaking period.—(1) Foods which have been subjected to dehydration are in a state of preservation primarily because of their low moisture content. The microorganisms responsible for spoilage commonly present in foods are unable to carry on their usual activities when the water content is sufficiently low. These organisms remain dormant in the dehydrated food but begin their activities when water is restored.

(2) After the addition of water, it is important to handle dehydrated foods rapidly. Prolonged soaking should be avoided. *Never soak vegetables overnight,* as long soaking may result in off-flavors and, in some cases, complete spoilage. However, a short soaking period will help in the rehydration of the dehydrated food. Twenty to thirty minutes' soaking time is sufficient. All vegetables, whenever possible, should be soaked for this short period of time.

(3) When conditions are such that this soaking period is too inconvenient, it may be eliminated. If the soaking period is eliminated, the vegetable with the water should be put on a slow heat and a few minutes may have to be added to the cooking time.

c. Cooking.—(1) After the soaking time, the products should be brought slowly to a boil in a covered utensil. The heat should be controlled so that when cooking a 100-portion recipe 35 to 45 minutes will elapse before the boiling point is reached. Smaller portions require less time. The product should be kept at a simmer boil at all times. Vigorous boiling should be avoided. The amount of simmering time necessarily depends upon the vegetable that is being prepared.

(2) The product should be simmered until it is tender, which may be determined by testing with a fork. If it is tough and rubbery, more cooking is required. Always be sure that a product is fully rehydrated and tender before stopping the simmering process.

(3) However, it is just as important to avoid overcooking. If a dehydrated product is overcooked, it will become mushy and disintegrate into the water. This is especially apt to happen when it is boiled vigorously or long, because it is necesarily cut in small sized pieces.

d. Surplus water.—(1) A small amount of surplus water is necessary if the product is to be properly rehydrated. The surplus water should be utilized in some manner as this water contains valuable water-soluble minerals and vitamins. These valuable nutrients are lost if the water is discarded.

(2) The small surplus should be concentrated to the point at which it can be served as a natural juice which would accompany fresh vegetables under normal circumstances. The surplus can also be drained from the vegetables and then used for stock or as the water ingredient for other cooked foods. For example, it may be used as a stock in preparing some meat loaves, etc. Surplus water from potatoes may be used to reconstitute the milk used in the whipping process of mashed potatoes. These are just a few suggestions for the use of surplus water.

e. Precooked foods.—(1) The above method of rehydration applies to dehydrated food that must be cooked as well as rehydrated—for example, dehydrated carrots, beets, onions, rutabagas, cabbage, sweet potatoes, and Julienne style white potatoes. These foods are cooked to some extent in the blanching and dehydration process, but they require further cooking upon rehydration. However, we do have dehydrated foods that are thoroughly cooked before dehydration and are called "precooked" dehydrated foods.

(2) The method of rehydration for this type differs from that used for a food that has not been cooked before dehydration. For example, a Julienne style potato has been blanched and then dehydrated. It is necessary to soak this potato in cold water, bring slowly to a boil, and then simmer for 20 minutes. However, a precooked dehydrated potato shred does not require this long cooking procedure. It is only necessary to add boiling water to the potato shreds, cover, let stand for 10 minutes, and then whip for mashed potatoes.

(3) The precooked products now in use include dehydrated precooked baked beans, dehydrated soups, and the potato shreds mentioned above. The method of rehydration differs with each precooked dehydrated product, so general rules will not apply. Specific instructions are necessary for each product.

SECTION X

STORAGE OF DEHYDRATED VEGETABLES

114. SEMIPERISHABLE NATURE.— All dehydrated vegetables should be treated as semiperishable items. Optimum storage conditions are in cool dry warehouses. Under such conditions the vegetables may be held for 18 to 24 months with no appreciable change in flavor or appearance. However, when dehydrated vegetables are stored in hot climates, certain items should be used within three months if the maximum value is to be obtained. Dehydrated carrots, cabbage, and white potatoes may discolor and develop objectionable flavors during extended storage.

115. EFFECT OF MOISTURE CONTENT.—More recent research on dehydrated vegetables has revealed that the storage life is limited very largely by the moisture content in the dehydrated product. Present specifications reflect the lowest commercially practicable moisture content attainable. Of the various possible means for achieving a lower moisture content, the use of in-can dehydration seems to be the most practicable. This practice involves the packaging of vegetables with containers of an active desiccant. To date, calcium oxide (burned lime) has proved most satisfactory in attaining the desired results—namely, extended storage life with accompanying preservation of color and flavor of the product.

116. STORAGE IN TRANSIT.—In shipment of dehydrated vegetables overseas, they should be stored away from hot areas such as bulkheads adjacent to the boiler or engine room. Protection should be provided from any other source of heat, such as high temperatures in temporary storage, during loading, and unloading operations.

117. OPENED CANS.—Cans of vegetables which have been opened and are not completely used should be covered as tightly as possible to reduce absorption of moisture, and stored in coolest and driest areas possible.

SECTION XI

SPECIFICATION CONTROL AND GRADING

118. SPECIFICATION.—Dehydrated vegetables for Army use are prepared according to Quartermaster Corps Specifications. All vegetables must be certified by qualified government inspectors as meeting their respective specifications prior to shipment. Table II shows a comparison of specification requirements for dehydrated vegetables.

119. INSPECTION.—Government inspectors make a thorough examination of the dehydration plant and the product, both raw and dehydrated, prior to certification. If the plant is in operation at the time of sampling, a check is made of plant sanitation, general processing, and packing methods. Unsanitary conditions of production are grounds for refusal to grade any product. Immediately after opening a container of dehydrated vegetables, the aroma of the product should be noted. Dehydrated vegetables have an odor characteristic of the fresh product and should not have a hay-like or other objectionable aroma. The color of the dehydrated product should resemble that of the fresh product. It should not be discolored or show indications of scorch or excessive oxidation. The entire contents of the container should be checked very carefully for foreign material such as metal, paint, dirt, soot, cinders, splinters, and filth.

120. DEFECTS.—Some of the obvious defects found in dehydrated vegetables are as follows:

a. Beets.—All units which are discolored or which show effects of careless processing. (Inspection of beets must be on the rehydrated product.)

b. Cabbage.—Units which are scorched, bruised, decayed, or otherwise discolored in whole or in part, or show evidence of tray blackening or insect damage.

c. Carrots.—Units containing pithy core, and which show areas of peel, insect damage, tray blackening, etc.

d. Potatoes.—Units which show red-brown discoloration, graying, peel, insect damage, etc.

121. OTHER REQUIREMENTS.—*a.* All samples of dehydrated vegetables must be rehydrated and examined for ease of rehydration, color, flavor, and texture of the product. Table III compares the specification requirements for rehydrated vegetables.

b. In addition to examining the dehydrated vegetable for compliance with the specification, examination is also made of the packaging. The present dehydrated vegetable specifications include very definite requirements for containers, lids, closures, liners, cartons, cases, strapping, and marketing.

TABLE II

COMPARISON OF SPECIFICATION REQUIREMENTS FOR DEHYDRATED VEGETABLE PRODUCTS (JULY 1945)

Product	Color	Aroma	Maximum moisture	Maximum fines	Defect tolerance*	Defects counted*
Julienne Beets	Typical, uniform dark red	Typical, free from hay-like, musty, scorched, rancid, etc., characteristics	5%	1% thru 8-mesh	4%	Insect or pathological damage; decay; scorch; bruise; tray-black; dirt; peel; tough core; discolor
Shredded Cabbage	Bright Typical	ditto	4%	15% thru 8-mesh	2%	ditto
Diced Carrots	ditto	ditto	4%	1% thru 8-mesh	2% total	ditto
Flaked Onions	ditto	ditto	4%	2% thru 14-mesh	2% total	ditto
Diced white potatoes	Typical	ditto	7%	1% thru 8-mesh	2% discolor 3% total	Peel; tray-black; pathological injury; scorch; bruise; eye; discolored—orange, pink, red, or brown
Riced white potatoes	ditto	ditto	ditto		1% total	ditto
Diced sweet potatoes	10% max. lemon 4% max. light yellow to white	ditto	6%	1% thru 8-mesh	2% total	Peel; tray-black; insect injury; decay; imbedded dirt; heavy fiber; discolored-green, black, or brown

* Defects are graded on the dehydrated product for all these vegetables except beets. The beet defects are determined after rehydration and cooking.

TABLE III

COMPARISON OF SPECIFICATION REQUIREMENTS FOR REHYDRATED VEGETABLE PRODUCTS

Product	Rehydration and Cooking				Color	Flavor	Texture
	Rehy. ratio	Soak	Heat to Boil	Simmer			
Diced beets	1-7	15 mins.	10-15 mins.	not over 30 mins.	Bright red; uniform	Typical	Tender and free from woodiness
Shredded cabbage	1-10	ditto	ditto	ditto	Bright; typical	Typical	Tender
Diced carrots	1-8	ditto	ditto	ditto	ditto	ditto	Tender and free from woodiness
Flaked onions	1-8	20 mins.	ditto	ditto	Typical; practically free from pink or brown	Pungent; typical	Tender
Diced white potatoes	1-7	15 mins.	ditto	ditto	Typical and will not darken in 10 mins.	Typical	Typical fairly mealy; not over 10% mushy or tough; not over 5% reddish orange, brown, or soggy centers
Riced white potatoes	1-4	Steam 10 minutes whip 2 minutes			ditto	ditto	Fairly mealy; reasonably free from gumminess, pastiness, and lumps
Diced sweet potatoes	1-4	15 mins.	10-15 mins.	not over 30 mins.	Reasonably bright and typical	Typical and free from sourness or bitterness	Soft and tender but not soggy or gummy

122. CERTIFICATE OF COMPLIANCE.—Following the examination of the vegetables, a certificate is filled out with the statement that the product meets or fails to meet quality requirements of the specification for the particular vegetable.

APPENDIX I

DEFINITIONS:

Dried, sun dried, evaporated, and dehydrated are terms used interchangeably in describing dry products. Although absolute definitions for these terms are not possible, a plausible breakdown might be as follows:

Dried—indicates drying by any means.

Sun Dried—indicates drying without artificial heat.

Evaporated—indicates the use of artificial heat. Evaporated refers more particularly to the use of artificial heat in driers depending for their air circulation on natural draft.

Dehydrated—indicates drying under conditions of controlled heat, air flow, and humidity. A dehydrated food product may be more definitely defined as a food product in which the major portion of the moisture has been removed by artificially produced heat under controlled conditions to the extent that preservation of the product is assured.

PART III

IRISH POTATOES

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SECTION I

INTRODUCTION

1. CROP IMPORTANCE.—White potatoes are the most valuable vegetable crop in the world. The average annual world production is about 6 billion bushels of which Russia and Germany produce 1½ billion bushels each, Poland about 1 billion, France 500 million, and the United States about 400 million. The per capita annual consumption of potatoes in the United States varies between 2.5 and 3 bushels. In addition to their normal use as food for human beings, large quantities are used in the production of potato flour, potato starch, stock feed, alcohol, and some types of yeast.

a. Crops.—(1) Early market or new potatoes come mainly from the Southern States. Approximately 15 percent of the total crop of the United States is produced in the Southern States; namely, in Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia. Southern growers usually harvest their crop before full maturity in order to get the benefit of the early high price. Early market potatoes are subject to water loss and discoloration and, because their skins are poorly developed, thin, and easily rubbed off, they are highly susceptible to decay. A large degree of injury results from the use of mechanical diggers, from throwing the tubers into slatted crates, and from running the potatoes over the grading machines immediately after digging. Allowing potatoes to mature before digging and care in handling will help reduce mechanical injury.

(2) Late or main-crop potatoes or old potatoes come from the Middle Atlantic and from the Northern States and constitute about 85 percent of the annual production of the United States. These potatoes have been allowed to mature naturally. Sometimes, where there is danger of disease in the crop, the practice of leaving the tubers in the soil an additional 10 to 15 days after maturity has a distinct advantage. The infected tubers start to rot in the ground, and can easily be discarded when they are dug. Tubers whose vines have been killed either accidentally, as by frost, animals, or parasites, or deliberately, as by chemicals to hasten tuber maturity, are also allowed to stay in the soil. These potatoes have a heavy, well-developed skin and are therefore suitable for storage. Mature potatoes are available the year round, but they are used to the greatest extent from October to April.

b. Market qualities.—The market qualities of potatoes are determined by their firmness, their texture, and their color. Other criteria for determining the grade of potatoes include minimum sizes and the absence of rot or other diseased conditions.

c. Economic importance.—Although the potato is grown in virtually all countries where agriculture is practiced, the greatest production occurs in those with temperate climates. It is of less vital importance in the United States, however, than it is in the other countries that lie within the Temperate Zone. This is true for several reasons: The high level of economic life in the United States has made it unnecessary to rely upon the potato as a cheap source of food; the sweet potato has become a substitute, especially in the Southern States; corn has been substituted as a source of stock food; and the great distance from farm to market has made the transportation of perishable foods difficult and expensive.

d. Varietal types.—(1) The number of varieties of potatoes is large; many have several names. On the following page, the table, Characteristics of Better-Known Varieties of the Potato, provides a brief description of the more common types.

(2) Sometimes potatoes are also classified as follows:

Round whites:	Katahdin
	Rural
	Russet Rural
	Cobbler
	Chippewa
Long whites:	Green Mountain
	White Rose
	Burbank
Round red:	Triumph

TABLE I

CHARACTERISTICS OF THE BETTER-KNOWN VARIETIES OF THE POTATO

Variety	Color of skin	Size	Shape	Color and texture of flesh	Usual season	Eyes	Skin	Remarks
Cobbler	Glossy creamy white	Large	Round Stem end shouldered deeply	White	Extra early	Numerous Medium to deep	Finely netted	Atlantic Coast, Kansas & Southwest
Burbank	White to dull white	Large	Long cylindrical or slightly flattened	Firm and Fine-grained	Medium late	Numerous Shallow	Netted Nearly smooth	Important in West Good cooking quality
Green Mountain	Bright creamy white to dull yellow	Medium	Moderately to distinctly oblong, usually blunt ends	Fine-grained	Medium to late	Sometimes considerably depressed	Slightly netted	Northeast United States Good table quality
Triumph	Creamy white with splashes of red or even solid red or pink	Medium	Roundish tending toward oblong in large tubers	Slightly tinted	Very early	Medium in number Rather shallow Cluster at bud end	Usually much netted	South Central United States Mealy when cooked
Rural	Smooth and white or entirely russet and dull brown	Large	Oval flattened to broadly round	White	Medium to late	Few Very shallow	Occasionally netted	North Central
Katahdin	Creamy buff	Large	Elliptical to round	White fine-grained	Late	Very shallow	Smooth	Northeast
Chippewa	Creamy buff	Large	Elliptical to long	White fine-grained	Medium	Shallow	Smooth	Midwest
Sebago	White	Large	Elliptical to round	White	Late	Shallow	Smooth	North Central

SECTION II

CULTURE

2. ESSENTIALS OF POTATO CULTURE.—*a. Climatic requirements.*—The principal climatic requirement of a good potato-producing area is a cool moist growing season with temperatures ranging from 60° to 70° F. Temperature conditions have a decided influence on the potato crop, not only on the yield, but also on the quality. The early maturing varieties of potatoes are planted as soon as the ground is in a workable condition and as early as possible after danger of frost is past. In the Northeast, the planting season may be as early as March 20, although most potatoes are planted in May.

b. Soil.—The type of soil for growing potatoes has a marked effect on yield, length of time required for the crop to attain maturity, eating quality, keeping quality, and resistance to disease. The ideal type of soil for growing potatoes is a sandy loam. Soils that are too sandy, however, are objectionable because they do not retain moisture and have such a high degree of heat conductivity that moisture may rapidly be forced out of the plant roots. On the other hand, a heavy clay soil is unsatisfactory since it seals the roots from necessary air. A waterlogged soil will cut off the air supply in the same way causing the early death of the plant.

c. Seed.—The seed of the potato is the bud or eye. Good seed stock is essential. The continued use of leftovers from the previous season's stock results in a progressively lower yield of increasingly inferior potatoes. When either seed or soil is suspected of containing scab or black scurf organisms, the seed must be disinfected prior to planting. Disinfection consists of immersing the uncut seed in a solution such as formaldehyde, mercuric chloride, corrosive sublimate, or organic mercury compounds.

d. Planting methods and cultivation.—The number of bushels of potatoes planted per acre, the distances between rows and between seed pieces, the use of a ridged or a level system of culture, and the depth of planting will all be affected by the size of the seed, the fertility and moisture-holding capacity of the soil, and the average rainfall. In view of regional variations in the foregoing factors, it is only possible to say that seed potatoes are sown at a rate ranging from 12 to 15 bushels per acre in rows varying from 30 to 36 inches apart. During preliminary growth, they are usually cultivated to remove weeds.

e. Spraying.—Potato plants are sprayed and dusted chiefly to control late blight, commonly known as "rust." Spraying will also control infestations of the Colorado potato beetle (otherwise known as the "potato bug") and the flea beetle. Bordeaux mixture, the most commonly used spray, is most effective when applied often enough to keep the plants well covered with spray.

f. Harvesting.—Potatoes in the Northern States are harvested between September and November either by elevator diggers or by hand, depending on the size of the farm. The potatoes are gathered in wooden splint baskets or slatted crates, then graded, sorted, and sacked. A recent development in harvesting potatoes has been the use of cleaning machines. Brushing and washing machines of various types are used. Cleaning improves the appearance of the potatoes as to brightness, and allows defects to become more noticeable. Since the southern crop is intended for the early market (March to August) it is shipped immediately.

SECTION III

MARKETING

3. TRANSPORTING THE CROP TO MARKET.—*a. Containers.*—Although custom has developed general trends in different parts of the country, there is no uniformity either of size or of material in containers used for marketing potatoes. The 100-pound burlap sack is by far the most widely used container for late-crop potatoes. In the Northeast, potatoes are marketed in 100-pound burlap sacks and 50-pound paper sacks; in the South, in barrels, 120-pound or 2-bushel burlap sacks, ½-barrel hampers, and in 50-pound hampers; in the West, in 150-pound, 120-pound, and 100-pound burlap sacks, in 100-pound lug boxes, and in ½-barrel hampers. Other containers such as jute or cotton bags, osnaburg cloth, cardboard cartons, and paper bags are used in varying sizes throughout the country.

b. Types of railroad cars used.—Most of the potato crop is marketed relatively far from the point of production. The type of car used for transportation depends upon the distance to be shipped and the temperature to be encountered en route. Practically all carlot shipments of late potatoes are made in refrigerated cars. These cars are equipped with floor racks to provide adequate ventilation. In cold weather, the floor rack and sides of the car to the height of the load are often lined with heavy paper or straw to prevent freezing injury. In extremely cold weather, when heaters are required, the general practice is to install a heater in one or both bunkers of the refrigerator car.

c. Cooling methods.—During warm weather, potatoes may be shipped in cars cooled by one of the following means: Standard ventilation, precooling, or icing.

(1) *Standard ventilation.*—When temperatures at harvesting time are moderate in the daytime and cool at night, it may be necessary to cool shipments that reach their destination within 2 or 3 days. On the other hand, potatoes shipped during July and August are often harvested during warm or hot, windy weather and when the air is dry. Since potatoes shipped under standard ventilation (i. e., with bunkers dry and open) are subjected to the temperature and the humidity that prevail at loading time and during transit, there is always the chance of their encountering unfavorable situations at the shipping point or along the route; in which case the potatoes will arrive in poor condition. Usually, however, there is very little change during transit in the temperature of potatoes shipped under standard ventilation. Except in the case of sudden changes in the temperature of the outside air, the potatoes remain throughout the trip within 5° F. of the temperature at loading time. But if the potatoes aver-

age 75° F. on arrival, they have doubtless encountered unfavorable temperatures at one point or another and will show considerable decay, poor appearance, excessive browning, scald spots, and withering.

(2) *Precooling.*—Cars of potatoes precooled long enough to reduce the average temperature of the load to about 60° F. should carry satisfactorily with bunkers empty for short transit periods. However, carlots depending on precooling alone for refrigeration are not recommended for shipment to distant points during hot weather, or for shipments to any point where it is probable that the cars will remain on track for several days before being unloaded.

(3) *Iced shipments.—(a)* When car bunkers are filled with ice and the car loaded with potatoes, the average temperature of the load, 55° F., is low enough to control effectively the development of decay during shipment. Refrigerated shipments usually present the most attractive appearance on arrival because the moisture that condenses on the cool tubers when the car door is opened gives them a bright, fresh appearance. Also, there is no appreciable withering of the tubers; and, generally, no browning or decay detracts from the appearance of the load.

(b) Cars which are pre-iced and then re-iced to capacity en route provide excellent refrigeration; the temperature of the carload under this method averages 46° F., a temperature even lower than is necessary. Although re-icing of cars may be advisable, depending on weather conditions and the length of the shipment, in general the potatoes are in no better condition on arrival than those in precooled cars. Because of the very low arrival temperature, the potatoes frequently become wet enough from condensation moisture to remain damp for several hours after unloading. This frequently provides favorable conditions for decay and the impairment of quality.

4. LOADING PATTERNS.—*a. General.*—To help offset damage in transit, both that occasioned by the jars and jolts of the conveyance and that resulting from unfavorable temperatures en route, various methods of arranging the sacks in the car have been developed. In one type of load common to Maine, sacks are placed flat, lengthwise of the car, 6 layers high, with the top layer 5 rows wide and the other layers 7 rows wide. This makes a stack of 40 sacks. There are 5 stacks in each end of the car allowing a space between the doors, which makes a carload of 400 sacks. A common practice is to arrange the sacks so that the stacks slope backward from the bottom to the top layer. This arrangement serves as a bulkhead in preventing the load from shifting. In some loads the sacks in the lower layer are stood on end with 3 or 4 upper layers lying flat upon them. It is a common practice, particularly in some western States, to load so

that a space is left between the walls and the sacks, thus permitting circulation of air and reducing the possibility of freezing injury. Freezing injury during shipment is most likely to occur to potatoes in the bags resting on the floor and in contact with the walls of the car. Figures 1 through 6 indicate graphically the various methods of loading sacks in cars.

b. Summer load (5-3-2-1 method).—This method is recommended for three hundred 100-pound bags. Bottom-layer bags are stowed in an upright position, 5 rows wide, and spaced so as to allow air lanes lengthwise of the car through the load for maximum air circulation between rows; the bottom layer must be spaced so that the weight of the center row in the second layer rests upon 3 rows. This arrangement prevents excessive weight on the center row of the bottom layer. Second-layer bags are stowed flat, crosswise of the car, in 3 rows spaced in order to allow air lanes between the rows lengthwise through the car, and to tie the rows in the bottom layers in position. Third-layer bags are stowed flat, crosswise of the car, in 2 rows spaced to allow air lanes between the rows and to tie the rows in the second layer in position. Fourth-layer bags are stowed flat, crosswise of the car, in 1 row and placed so that the rows in the third layer are tied in position. (See fig. 1.) The bags are now stowed tight from one end of the car to the other, including the doorway space, and the load is protected against shifting. Usually 30 bags in each row of the bottom layer and 25 bags in each row of the other layers will take up the full length of the car; but when space permits, additional bags may be added in order to use all the lengthwise space and thus insure a tight load.

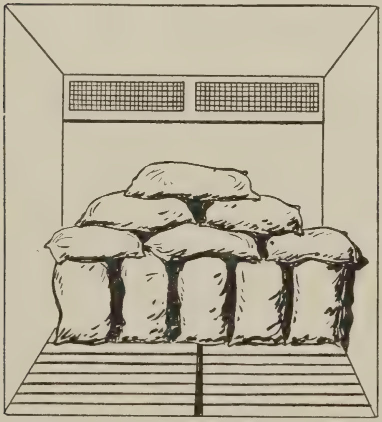


Figure 1.—The 5-3-2-1 method of loading. This method is used during the summer season for a load of 300 100-pound bags.

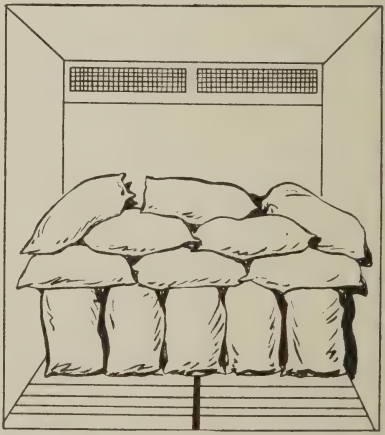


Figure 2.—The 5-3-2-3 method of loading. This method is used during the summer season for a load of 360 100-pound bags.

A sufficient number of bags will be omitted from the top layer, however, to offset the extra bags used in the other layers; the recommended load, it will be noted, is three hundred 100-pound bags.

Analysis of load:

Bottom layer	5 rows of 30 bags	150 bags
Second layer	3 rows of 25 bags	75 bags
Third layer	2 rows of 25 bags	50 bags
Fourth layer	1 row of 25 bags	25 bags
	Total	300 bags

c. Summer load (5-3-2-3 method).—This method is recommended for three hundred and sixty 100-pound bags. The bags are stowed the same as in the 5-3-2-1 method except that the fourth layer contains two additional rows of bags placed next to the side walls. The rows run from each end of the car to the center, where a space is allowable for the doorway. Fourth-layer bags are stowed flat, crosswise of the car, and, except the center row, at an angle; the bags at an angle rest on the bags in the second and third layers. Bags remaining after the fourth layer is complete are stowed as a partial fifth layer in two flat crosswise rows on each side of the doorway so as to tie the bags in the fourth layer.

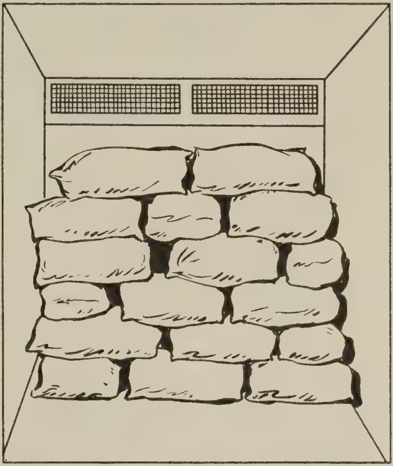


Figure 3.—Ventilated tied-bulkhead method of loading. This method is used during the fall and winter seasons for a load of 360 100-pound bags.

Analysis of load:

Bottom layer	5 rows of 30 bags	150 bags
Second layer	3 rows of 25 bags	75 bags
Third layer	2 rows of 25 bags	50 bags
Fourth layer	1 row of 25 bags	25 bags
	2 rows of 22 bags	44 bags
Fifth layer	2 rows of 8 bags	16 bags
	Total	360 bags

In some cases, the dimensions of the bags and the length of the car will permit stowing 32 bags in each row of the bottom layer and 26 bags in each row of the second and third layers and the center row of fourth layer. The foregoing loading (see fig. 2) should be followed when conditions permit since it eliminates, as is desirable, the fifth layer.

d. Fall and Winter load (ventilated tied-bulkhead method).—This method (see fig. 3) is recommended for three hundred and sixty 100-pound bags. Each stack contains 29 bags. There are 5 layers of 5 bags, each stowed 1 bag lengthwise and 4 bags crosswise of the car; in the sixth or top layer there are 4 bags, stowed crosswise. Five stacks are placed in each end of the car and 2 rows of 35 bags each are stowed crosswise in the doorway area and so placed as to brace the stacks in each end of the car and to allow about 16 inches of space between the door openings and the loading on each side. Bags are stowed tight from one end of the car to the other to protect against shifting in transit. Crosswise space is allowed between the bags in all layers to permit air circulation through the load. Bags next to the side walls in the bottom layer are stowed about 8 inches from the wall to allow maximum space between bags. This space is gradually reduced in each layer which pyramids the load and protects it against side shifting. Paper covering over the floor racks is an important factor in protecting the loading since it helps to insulate the floor layer against both freezing and bruising damage.

Analysis of load:

5 stacks in each end of car	10 stacks of 29 bags each	290 bags
2 rows in doorway of car	35 bags each	70 bags
	Total	360 bags

e. Aisle loading.—This is the recommended method of stacking for a 300-stack aisle load. In this method of loading (see fig. 4), 3 bags are placed upright, crosswise of the car, and leaned against the end wall of the car. An aisle space is left, and then three more upright bags are set in place across from them. Upon each row of these upright bags, 3 bags are piled horizontally to tie the vertical or upright ones together. The horizontal bags are inclined toward the car side; that is, the first bag is placed a few inches from the car side, the second closer but not touching the car side, the third or top bag touching the side of the car. With this load, inspection is easy at the shipping point, but at the terminal market there is often such a jumble of sacks in the aisle that there is no advantage over the pyramid load as far as inspection goes. It is impractical to load more than 300 sacks in a car by this method.

f. Doorway loading.—Loading the doorway space solid yet allowing for air circulation provides protection against shifting of sacks and damage to the potatoes. The method is shown in figure 5.

g. Air circulation in winter and summer loading.—During shipments utilizing standard ventilation, the bunkers are open. Where heaters are employed, as in winter shipments, or ice, as in the case of summer transportation, the bunkers are closed, the purpose being to effect the circulation of air through the load as is indicated in figure 6. The flow of air in the winter load is clockwise since the cold air is drawn into the lower areas of the heated compartment, rises to the top and flows down onto the load and, presumably, through the load until it is modified by the cold

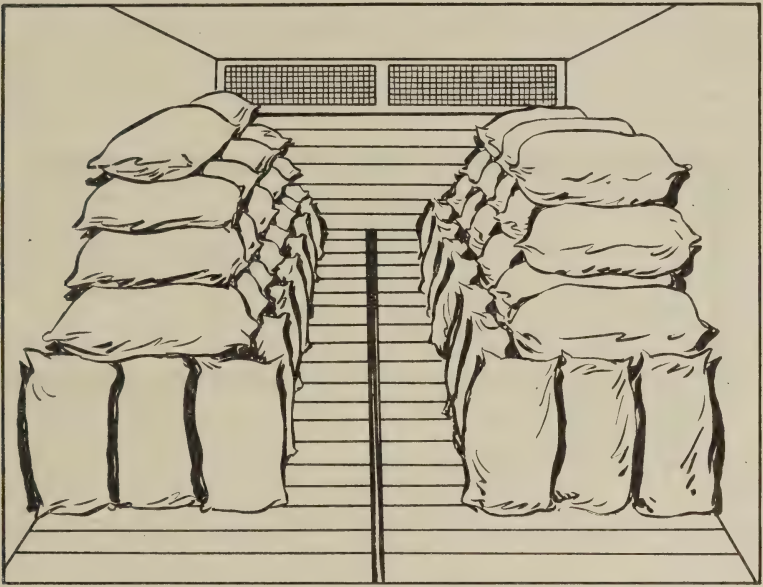


Figure 4.—Aisle loading. Three hundred 100-pound sacks.

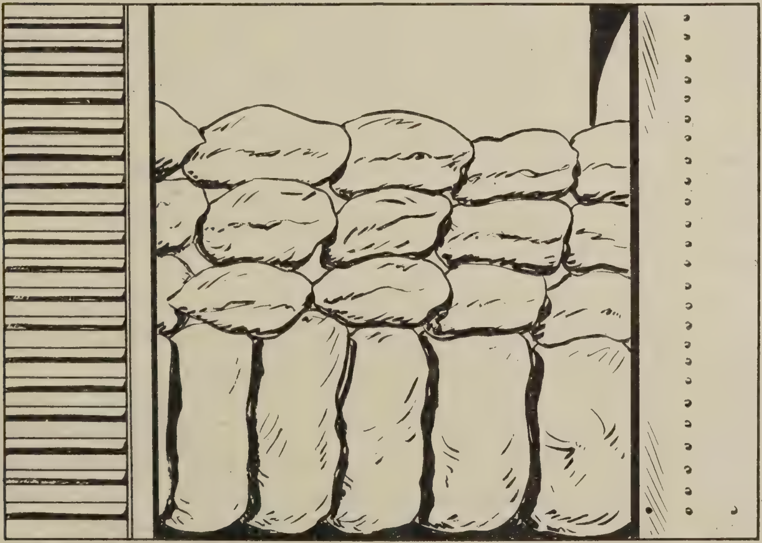


Figure 5.—Doorway loading. Note provision for circulation of air.

air near the floor. The circulation of air in the summer load is counterclockwise since the cold air flowing off the ice compartment enters the load at the bottom and as it is warmed rises through the load and returns to the ice compartment at the top. It should be understood that the foregoing explanation is useful only in providing the general picture of air circulation in the two instances, the physical aspects of air movement being too complex to describe in detail here.

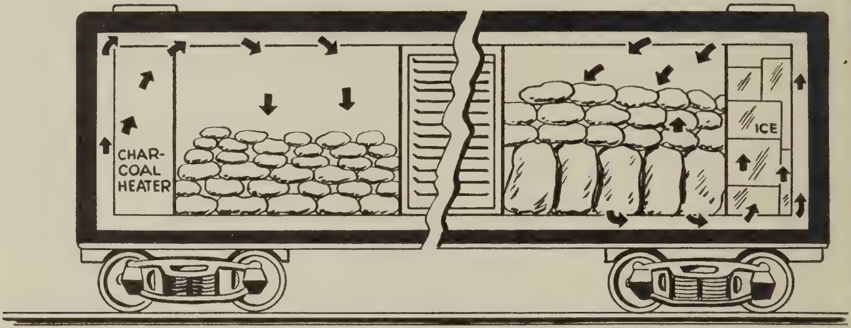


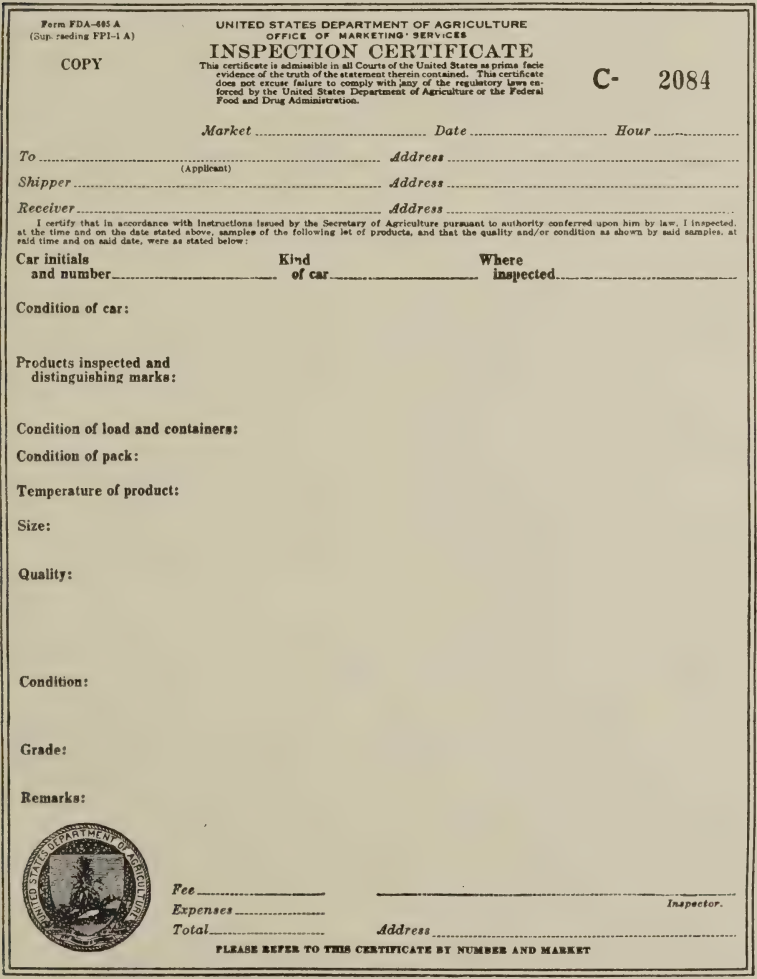
Figure 6.—Left: Winter loading with charcoal heater in bunker. Bunker top is closed and air circulates clockwise.
Right: Summer loading with ice in bunker. Bunker top is closed and air circulates counterclockwise.

5. SHIPPING BY WATER.—In Maine, many farmers prefer transportation by ship because of the saving in freight cost. However, this type of shipping is infrequently used because transfer to the ship, the depth and weight of the potato stock pile in the hold, and rehandling during unloading cause more damage than does shipment by rail.

6. TRUCK SHIPMENTS.—Although transportation by truck is satisfactory in most cases, rough roads may cause the potatoes to bruise. However, truck shipment is heavy in producing areas located near large cities. A large part of the truck movement of potatoes takes place within a radius of 100 to 125 miles.

7. GRADES AND STANDARDS.—*a. General.*—Before 1930, many farmers loaded their potato crop directly into cars without grading or packing. This procedure incurred freight charges on rejects, additional labor cost, and loss of potential food for farm stock, besides the actual cost of disposing of the rejected load. In 1930, the United States Standards for Potatoes were introduced by the United States Department of Agriculture, instigating grading and packing on the farm. Either machines or hand work are employed for this grading, depending on the locality, size of farm, type of crop, and cost of labor. Most State laws require that

potatoes offered for sale shall be graded in conformity with official standards and the container marked with the grade, net content, and name and address of the person responsible for packing. The use of official grading standards and the Federal-State inspection service facilitates transactions between shippers and distant buyers, furnishes a basis for contract sales, and discourages rejection of shipments at the market without just cause. An inspection certificate showing detailed information concerning the shipment is shown in figure 7. An inspection certificate is an aid in settling



Form FDA-605 A
(Superseding FPI-1 A)

COPY

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF MARKETING SERVICES

INSPECTION CERTIFICATE

This certificate is admissible in all Courts of the United States as prima facie evidence of the truth of the statement therein contained. This certificate does not excuse failure to comply with any of the regulatory laws enforced by the United States Department of Agriculture or the Federal Food and Drug Administration.

C- 2084

Market .... *Date* .... *Hour* ....

To .... (Applicant) *Address* ....

Shipper .... *Address* ....

Receiver .... *Address* ....

I certify that in accordance with instructions issued by the Secretary of Agriculture pursuant to authority conferred upon him by law, I inspected, at the time and on the date stated above, samples of the following lot of products, and that the quality and/or condition as shown by said samples, at said time and on said date, were as stated below:

Car initials and number.................. **Kind of car**.................. **Where inspected**..................

Condition of car:

Products inspected and distinguishing marks:

Condition of load and containers:

Condition of pack:

Temperature of product:

Size:

Quality:

Condition:

Grade:

Remarks:

Fee ....
Expenses ....
Total ....

.... *Inspector.*

Address ....

PLEASE REFER TO THIS CERTIFICATE BY NUMBER AND MARKET

Figure 7.—Inspection Certificate.

damage claims with the transportation company or the shipper. If freezing injury or excessive decay is present, which was not evident at the time of shipping, buyers may request a repeat inspection for potato condition at the receiving point. The reinspection made by a Fedreal-State inspector will either uphold or reverse the original certificate, depending on his findings. A Federal-State inspection certificate is accepted as prima facie evidence in any United States Court. The use of official grading standards together with the inspection service has encouraged farmers to produce potatoes of good quality and shippers to pack properly.

b. Nature and use.—Potato grades and standards are based largely on quality considerations in which defects in individual potatoes, or the percentage of these defects in a lot, play an important part. Grades further include such classification groups as size and variety. These grades are used as technical or trading terms in the marketing of potatoes and are particularly valuable when buyers and sellers are handicapped by an intervening long distance and trading must be accomplished without personal inspection. The system of grading now in use, together with regulations and practices under which the grades are used, has been a material aid in marketing to both buyers and sellers.

c. Standards as employed in marketing.—(1) When a grade name is attached to a lot of potatoes, it describes to the buyer the quality, characteristics, and the classification of that lot. Variations in market prices on any particular product are usually the result of the application of these grading standards. However, one of the most difficult problems in marketing is that of determining the price of a product by finding and applying standards of quality and classification which adequately describe the product. The possibility for misunderstanding between buyers and sellers is greatly increased when wide variations in price occur because of wide variations in market value within a grade.

(2) The U. S. No. 1 Grade for potatoes contains a minimum size requirement of 1⅞ inches in diameter, unless otherwise specified. If more than 3 percent by weight of the potatoes in a lot are below this size requirement or any other specified minimum size, the lot cannot be accepted as U. S. No. 1 Grade. In the potato grade, however, only a minimum size requirement is specified, whereas size in general is one of the most important factors contributing to differences in market price. It has been the general policy of the grading authority to leave the matter of size, except that of minimum size, to the contracting agents in any transaction. A contract for U. S. No. 1 Grade potatoes may be fulfilled by delivery of a lot of potatoes none of which are much in excess of 1⅞ inches, so long as not more than 3 percent by weight are smaller. Potatoes of this size are

so small as to be unsatisfactory to most consumers. In recognition of this fact, various subclassifications in regard to size were provided in the U. S. Standards for use in connection with the grade designation.

(3) One of the subclassifications of U. S. No. 1 Grade is U. S. No. 1, size A, in which not less than 60 percent by weight of the potatoes of round varieties shall be 2¼ inches or larger in diameter. In addition to such classifications, other minimum sizes may be specified, such as U. S. No. 1, 2-inch minimum, in which none of the potatoes can be below 2 inches in diameter with the exception of the 3 percent by weight allowed in the tolerance. These subclassifications in regard to size have materially improved the description of the potatoes included in any lot, since they indicate more clearly than formerly whether or not the potatoes are suitable for table use. But even these classifications include a very wide range of sizes, whereas most consumers prefer to buy potatoes classified within a rather narrow range of sizes. Potatoes of a size for baking are preferred, since, as a general rule, they are also suitable for most other uses. The difficulty in the use of the standard arises in the fact that the grade terminology for U. S. No. 1, size A, or for U. S. No. 1, 2-inch minimum, is equally satisfactory for U. S. No. 1. In addition, lots of potatoes in which a very large proportion are between 1⅞ and 2 inches in size are properly described as U. S. No. 1, but are much less satisfactory for use by most consumers than the larger sizes.

d. Description terms in common use.—The following definitions apply to descriptive terms used in the U. S. Standards for Potatoes:*

(1) "Mature" means that the outer skin (epidermis) does not loosen or "feather" readily during the ordinary methods of handling.

(2) "Bright" means practically free from dirt or other foreign matter, and that the outer skin (epidermis) has the attractive color normal for the variety.

(3) "Well shaped" means the normal shape for the variety, but also that the potato is not pointed, dumbbell-shaped, excessively elongated, or otherwise ill-formed.

(4) "Soft rot or wet breakdown" means any soft, mushy, or leaky condition of the tissue such as slimy soft rot, leak, or wet breakdown following freezing injury or sunscald.

(5) "Internal discoloration" means discoloration such as is caused by net necrosis or any other type of necrosis, stem-end browning, internal brown spot, or other similar types of discoloration not visible externally, except blackheart.

(6) "Injury" means any defect which more than slightly affects the

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*U. S. Standards for Potatoes are obtainable from the U. S. Department of Agriculture, Production and Marketing Administration, Inspection Division of Fresh Fruits and Vegetables.

shipping quality or the appearance of the individual potato, or the general appearance of the potatoes in the container, or a defect which cannot be removed without a loss of more than 2 percent at the total weight of the potato including the peel covering the defective area.

(7) "Damage" means any injury or defect which materially injures the shipping quality of the appearance of the individual potato, or the general appearance of the potatoes in the container, or any defect which cannot be removed without a loss of more than 5 percent of the total weight of the potato including the peel covering the defective area. Loss of outer skin (epidermis) shall not be considered as damage unless the skinned surface is materially affected by very dark discoloration. Any one of the following defects or any combination of defects, the seriousness of which exceeds the maximum allowed for any one defect, shall be considered as damage:

(a) Second growth or growth cracks which have developed to such an extent as to injure materially the appearance of the individual potato or the general appearance of the potatoes in the container.

(b) Air cracks which are deep, or shallow air cracks which materially injure the appearance of the individual potato or the general appearance of the potatoes in the container.

(c) Shriveling, if the potato is more than moderately shriveled, spongy, or flabby.

(d) Sprouting, if more than 10 percent of the potatoes have sprouts over three-fourths of an inch long.

(e) Surface scab which covers an area of more than 5 percent of the aggregate surface of the potato.

(f) Fitted scab which affects the appearance of the potato to a greater extent than the amount of surface scab permitted or causes a loss of more than 5 percent of the total weight of the potato including the peel covering the defective area.

(g) Wireworm, grass root, or similar injury, if any hole on potatoes ranging in size from 6 to 8 ounces is longer than ¾ inch or if the aggregate length of all holes is more than 1¼ inches. Smaller potatoes may have lesser amounts and larger potatoes may have greater amounts, provided that the removal of the injury by proper trimming does not cause the appearance of such potatoes to be injured to a greater extent than that caused by the proper trimming of such injury permitted on a 6- to 8-ounce potato.

(h) Dirt, if the general appearance of the potatoes in the container is more than slightly dirty or stained, or if individual potatoes are badly

caked with dirt or badly stained; or other foreign matter if it materially affects the appearance of the potatoes.

(8) "Serious damage" means any injury or defect which seriously injures the appearance of the individual potato or the general appearance of the potatoes in the container, or which cannot be removed without a loss of more than 10 percent of the total weight of the potato including the peel covering the defective area. Any one of the following defects or any combination of defects the seriousness of which exceeds the maximum allowed for any one defect shall be considered as serious damage:

(a) Dirt, if the general appearance of the potatoes in the container is seriously affected by tubers badly caked with dirt; or other foreign matter if it seriously affects the appearance of the potatoes.

(b) Fairly smooth cuts such as are made by the digger or by a knife to remove injury when both ends are clipped; or when more than an estimated one-fourth of the potato is cut away; or, in the case of the long varieties, when the remaining portion of the clipped potato weighs less than 6 ounces. Irregular types of cuts which seriously affect the appearance of the individual potato, or which cannot be removed without a loss of more than 10 percent of the total weight of the potato including peel covering defective area.

(c) Shriveling, if the potato is excessively shriveled, spongy, or flabby.

e. Standard tolerance for defects.—In addition to establishing size requirements, the U. S. Standards provide tolerance for defects. Since this tolerance is usually described in rather narrow limits, it is not so serious as the problem of size. Nevertheless, it does constitute a problem in marketing which should not be overlooked. The tolerance for defects permitted in U. S. No. 1 Grade is 6 percent by weight of the potatoes, of which not more than 1 percent by weight shall be affected by soft rot or wet breakdown and not more than 5 percent shall be damaged by hollow heart and internal discoloration. However, damage causing additional defects is almost certain to occur in the process of marketing. In other words, if the shipper in packing his peck packages uses a full 6-percent tolerance at the time of packing, it is probable that when the package arrives in the home of a consumer the percentage of defects will be greater. It is desirable that defects be held to a minimum in the consumer package.

f. Caution.—Grading terminology, when used in contractual relations between dealers who thoroughly understand it, is satisfactory because an adequate description of sizes required is likely to be included in the trading contract. However, deception may arise when this grading terminology is used to describe the quality within consumer packages or even in 100-pound bags sold to the retailers or to consumers who are much less familiar with the problems of grading. Instances have been noted in which potatoes of small size, but not too small to meet the minimum size requirements for U. S. No. 1, have been placed in peck packages marked U. S. No. 1. When sold to consumers, considerable criticism of sizing has resulted.

g. Grading for wholesalers and grading for consumers.—Though at present there is a difference between grading for wholesale trading and for consumer trading, the basis for purchase on the part of wholesale dealers should be in terms of preferences which are transmitted to them by consumers. Grading is done for consumers and should, as far as possible, be done very carefully in the first instance since rehandling is a source of additional cost. The practice of grading for wholesale purposes at the shipping point permits the inclusion of defects and is not accomplished with sufficient precision to make the sizing satisfactory for retailing purposes.

SECTION IV

STORAGE

8. GENERAL.—A potato is a living, breathing plant tissue. As it reathes, carbon dioxide, moisture, and heat are given off. Little attenion need be given to the carbon dioxide because storage construction is eldom so tight that this gas accumulates in quantities where it would ither be beneficial in retarding respiration and sprouting or where greater oncentration would be detrimental in promoting blackheart. Evaporation f moisture from potatoes reduces the quantity of potatoes for sale. This actor requires attention in designing storage facilities so that moisture vhich condenses on the cold walls and ceilings will do no harm to the uilding or to the potatoes.

a. Heat of respiration during storage.—The fact that potatoes respire nd give off heat is indicated in the following storage observations: Four hundred bushels of potatoes stored at 52° F. and cooled to 44° F., luring the first month of storage will give off more than a barrel of water y evaporation, but during the month of January when the temperature s about 40° F., about one-fifth as much water will be given off. The eat of respiration of those 400 bushels of potatoes during the first month f storage will be equivalent to that available when 100 pounds of coal are urned in the average stove, which is about 50 percent efficient. The heat f respiration during January may be from one-half to one-fifth as much. Thus the heat of respiration of potatoes is readily available in the fall when its disposal is a problem and is least available in January when it could e used to advantage.

b. Removal of heat.—In addition to the heat of respiration, potatoes ontain a large amount of field heat when stored which must be removed n lowering their temperature. To absorb the field heat of 400 bushels f potatoes while their temperature is lowered from 52° to 44° F. during he first month of storage, more than 1,000 pounds of ice would have to be melted. This removal of heat is commonly obtained by ventilation and onduction through the storage walls and ceiling. Additional heat which nust be removed comes from the earth through the storage floor and walls, r from the outside air through the walls and the ceiling during warm veather.

c. Potato storage requirements.—Potatoes are stored either in cold or ommon storage, but the greater part of the crop that is stored is held in ommon storage, i. e., storage in which the proper temperature is obtained s nearly as possible by insulation and ventilation only. The principal otato storage requirements are control of temperature and humidity within a narrow range for a period often as long as 8 months during which time there is a wide range of outside temperature and humidity. Also, the storage should protect the potatoes from moisture, sun or artificial light, and from mechanical injury. Potatoes intended for storage should be handled carefully to avoid bruises and cuts; otherwise, they are likely to be damaged by various forms of decay before the end of the storage period.

9. STORAGE TEMPERATURES.—*a. Desirable temperatures for newly harvested potatoes.*—Storage temperature studies have shown that the immediate subjection of newly harvested potatoes to low temperatures, 36° to 42° F., is undesirable. These investigations revealed that abrasions, cuts, and bruises on the surface of the tuber do not heal properly at temperatures below 50° F., provided, of course, that the surface of the potato is similarly cooled. Also, below 50° F. skin abrasions, cuts, and bruises turn dark and become shrunken underneath. On the other hand, if newly harvested potatoes, especially those somewhat immature, are subjected to a temperature of about 60° F. and 90 percent relative humidity for the first 2 weeks of their storage period, the injured tissues of the potatoes will quickly heal over, provided the wound has not become infected with a disease organism. After this brief period of relatively high temperature, the storage house should gradually be cooled to a temperature ranging from 45° to 40° F. At temperatures of 32° to 36° F. an appreciable amount of tuber rot will develop in the injured areas, and there is a tendency for potatoes to become undesirably sweet. However, if sweetening occurs, a few days' exposure to temperatures in the range of 65° to 75° F. will partly restore the natural flavor.

b. Optimum temperatures for long storage periods.—In general, storage temperatures of 50° F. or higher result in high quality table stock, but potatoes can be stored for only 12 to 14 weeks at this temperature without excessive shrinkage and early sprouting. A temperature of approximately 40° F. has been found to be a most desirable compromise for long storage periods because at this temperature the shrinkage is very small, the cooking quality remains good, and sprouting is retarded.

c. Storage temperatures during final 2 weeks.—During the last 2 weeks of storage it is often desirable to raise the storage temperature to about 50° F. to reduce injury during grading and sacking. The warming of a bin from 40° to 50° F. during the last 2 weeks of storage is often a problem because adjoining bins may be intended for continuous storage at 40° F. Heating may be accomplished by forcing warm air into floor flues, or by using force during grading to move warm air over the top of the inclined pile of potatoes. Since the sole function of storage is to preserve the stored product in as nearly its original condition as possible, he most advantageous temperature is that which will maintain the tubers n a firm and ungerminated state and at the same time hold diseases in heck.

10. HUMIDITY AND VENTILATION.—*a. Humidity.*—A relative umidity of 85 to 90 percent is recommended for potato storage. This umidity is high enough to retard shrinkage and low enough under average tmospheric conditions to prevent the formation of free moisture on the urface of the potatoes.

b. Ventilation.—(See figs. 8 and 9.) During the first 2 or 3 weeks of he storage period little ventilation is advisable. Once the wounds and brasions of the tuber have healed over, however, sufficient cold air should e admitted to remove excess moisture and reduce the temperature. The ir intakes and outlets should be so arranged as to insure a rapid and ven distribution of air throughout the storage house. Ventilation serves s the quickest means of changing both temperature and humidity within storage house. Moving air is the principal means of conveying heat nd moisture between cold and warm spaces and between the wet and ry areas. Storage houses should be designed so that there is adequate pace between the top of the bins and the ceiling to permit free circulation f air. It is especially important that there be circulation spaces between he stored potatoes and the exterior wall whether it is above or below round. To make wall circulation effective, the wall circulation space hould be open to the air above the bins; and at the bottom it should connect ith the horizontal flues extending entirely around the storage area and pening into the work alley near the air-intake door.

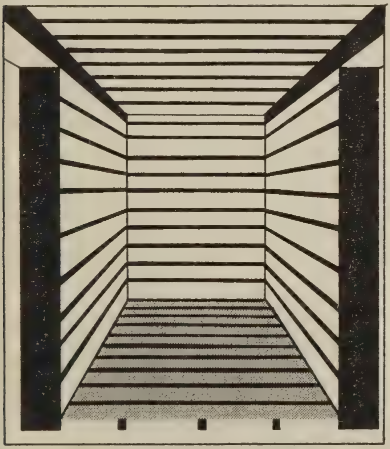

***Figure 8.*—Potato bin. Construction shows slatted sides and floor. This type of bin provides abundant ventilation.**

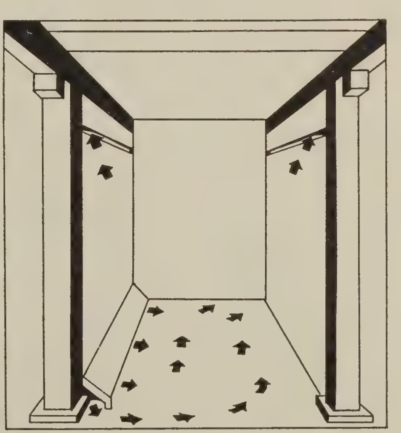

***Figure 9.*—Potato bin. Tight bin construction with a cat walk for ventilation.**

c. Regulation of ventilation and humidity.—Ventilation is subject to a wide range of regulation; it may vary from forced ventilation to the ventilation afforded by the smallest of cracks. Forced ventilation is liable to remove too much moisture from the storage house and thus lower the humidity. Although some moisture is also removed from the storage air by condensation upon the cold walls and ceiling surfaces, moisture condensed on walls may be drained away without harming the potatoes. Condensation and evaporation are becoming increasingly recognized as useful humidity regulators since they continue without the attention of the storage operator.

d. Night ventilation.—Night ventilation removes heat with a minimum effect on the moisture. Also, night ventilation is more desirable in the fall as it lowers the temperature and yet maintains high storage humidity. Day ventilation may be more desirable in the winter as it lowers the humidity and reduces ceiling condensation while maintaining desirable temperatures. During the winter months, in well-designed storage, little ventilation is usually required but it may be needed during unseasonably warm weather in winter or in storage areas filled beyond their normal capacity. In the spring months, night ventilation may be used to keep the storage temperature below the outside daily temperature. In general, for fall ventilation, it is advisable to take advantage of outside temperature and humidity to maintain proper storage conditions.

e. Effective insulation.—The efficient regulation of storage house temperature and humidity is dependent on effective insulation. Figure 10

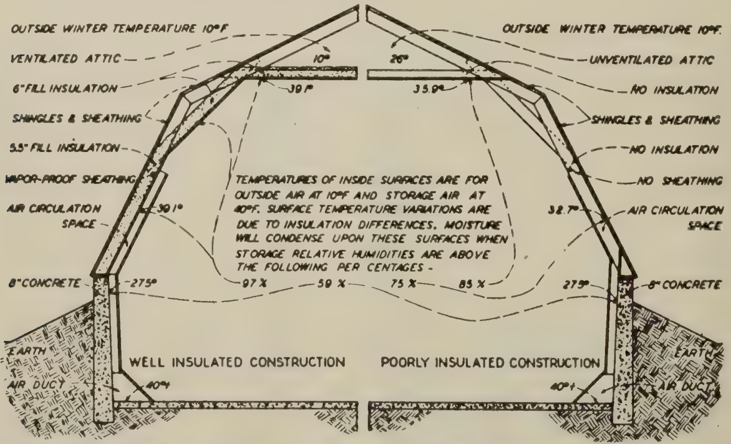
OUTSIDE WINTER TEMPERATURE 10°F
VENTILATED ATTIC
6" FILL INSULATION
SHINGLES & SHEATHING
5.5" FILL INSULATION
VAPOR-PROOF SHEATHING
AIR CIRCULATION SPACE
8" CONCRETE
EARTH
AIR DUCT
10°
39 F
39.1°
27.5°
40°
OUTSIDE WINTER TEMPERATURE 10°F.
UNVENTILATED ATTIC
NO INSULATION
SHINGLES & SHEATHING
NO INSULATION
NO SHEATHING
AIR CIRCULATION SPACE
8" CONCRETE
EARTH
AIR DUCT
26°
35.9°
38.7°
27.5°
40°
TEMPERATURES OF INSIDE SURFACES ARE FOR OUTSIDE AIR AT 10°F AND STORAGE AIR AT 40°F. SURFACE TEMPERATURE VARIATIONS ARE DUE TO INSULATION DIFFERENCES. MOISTURE WILL CONDENSE UPON THESE SURFACES WHEN STORAGE RELATIVE HUMIDITIES ARE ABOVE THE FOLLOWING PER CENTAGES -
97 %
59 %
75 %
85 %
WELL INSULATED CONSTRUCTION
POORLY INSULATED CONSTRUCTION

Figure 10.—Comparison of inside wall surface temperatures and storage relative humidities at which moisture will condense upon these surfaces for well-insulated and poorly insulated storages. Note that the wall air-circulation space is between the wall surfaces and the stored potatoes.

shows the variation in relative humidity and temperature in a well-insulated and a poorly insulated storage house. In good storage houses the ceiling should be more heavily insulated than the side walls in order that most of the condensation take place on the side walls. The side walls should be waterproofed with some material such as roofing paper, aluminum paint, galvanized iron, or emulsified asphalt to prevent decay.

f. Other considerations.—(1) Potato bins in the storage house should be constructed so that the potatoes may be conveniently unloaded and properly ventilated. In some houses bins have slatted inner walls with an air space between the outer and inner walls. The wall space has two purposes: it provides adequate circulation of air around the bin in conjunction with the wall floor corner flues; and it prevents freezing damage to potatoes stored next to the outside wall.

(2) Wall floor flues or ducts should be built in bins to let in the cool outside air in order to allow it to rise through the mass of potatoes. Wall floor flues are triangular ducts at the junction of wall and floor made by nailing 1-inch boards diagonally at 45° from the wall to the floor as shown in figure 10. The wall floor flues should extend continuously around the bins and whenever possible should lead into a large open space such as the elevator pit, which acts as a mixing chamber into which outside air can enter and mix with warm air of the house before coming in contact with the potatoes.

(3) When potatoes are stored 6 feet deep, 1 square foot of floor space will store 240 pounds of potatoes. The following statistics may be useful in determining bin capacity:

1 100-pound sack = 2.5 cubic feet
1 bushel = 1.5 cubic feet
1 cubic foot = 0.66 bushel
1 cubic foot = 40 pounds

11. GENERAL STORAGE REQUIREMENTS.—The general requirements for successful storage of potatoes may be summarized as follows:

a. Protection from cold and heat.—The potatoes must be protected from extremes of cold and heat. Initial storage for 2 to 3 weeks at 55° to 60° F. is advantageous to reduce shrinkage, to heal cuts and bruises, and to improve cooking quality. Although the best storage temperature for holding potatoes is from 38° to 40° F., temperatures ranging from 35° to 45° F. are considered satisfactory.

b. Need for ventilation.—Sufficient ventilation must be provided to remove foul air and excess moisture.

c. Protection from light.—The storage house must be so constructed as to make it possible to exclude light, since the palatability of potatoes quickly deteriorates in light, and the potatoes develop a green discoloration.

d. Protection from moisture and soil.—The tubers should be dry, mature, and reasonably free from dirt when put into storage. An excess of moisture or of soil increases the amount of heat generated in a newly stored pile of potatoes. The soil tends to close up the spaces between the tubers, thus cutting off air circulation and helping to retain heat that would otherwise escape.

e. Protection from damaged tubers.—All diseased, badly cut, or bruised tubers should be removed before potatoes are placed in storage.

f. Other requirements.—It is not advisable to store potatoes at a depth greater than 6 feet. The floor dimensions of the bin should be not greater than 12 feet by 12 feet, unless the bin is provided with a series of ventilating shafts. Floor divisions and a ventilated wall are also desirable.

DAMAGE IN GROWTH AND STORAGE

12. GENERAL.—One of the most important factors affecting the aketability of potatoes is appearance. The potato may have its appear-nce marred by insects, diseases, and mechanical or chemical injury. When rtain insects and diseases attack the vines of the plant, the food supply the tubers is reduced with the result that small, poorly shaped, poorly olored, or flabby tubers develop. Pathological conditions affect the pota-oes directly and may be induced in the field, in storage, or in transit ter harvest. Insect damage is distinguishable from that caused by disease y means of the skin penetrations or punctures effected by the attacking est. Some of the common insects, diseases, and injuries affecting pota-oes and their control are discussed in the following paragraphs.

13. INSECTS.—*a. Colorado potato beetles.*—The yellow- and black-riped beetle and the brick-red larva are usually referred to as "potato ugs." Potato bugs lay their orange-colored eggs on the under side of he leaves. Both the larva and the full-grown beetle consume the plant aves and scar the stems. On small acreages, the beetle can be controlled y hand-picking and killing. An arsenical spray or dust, such as calcium rsenate, is an effective control.

b. Flea beetles.—These are small dark-colored beetles which, when isturbed, jump away much like fleas. They injure the vine by gnawing mall holes through the leaves, usually starting from the under side. Spray-ng with Bordeaux mixture will control this pest.

c. Aphids.—Aphids are tiny green or pink plant lice which cluster on he terminal shoots and under the leaves. These insects live on the plant uices and frequently cause the leaves to curl. A spray or dust insecticide uch as nicotine compound is effective against aphids.

d. Leafhoppers.—Leafhoppers are minute green insects which fly for hort distances when disturbed. During hot seasons they cause hopper-urn, or tipburn, which appears as a browned area at the tips and borders f leaves. Applications of Bordeaux mixture are a satisfactory control.

e. Other insect or animal damage.—Potatoes are also attacked by cut-vorms, tuber moths, psyllids, wireworms (see fig. 11), grubs, mice, nd rabbits.

f. Promising new control.—With respect to insect control, the recently eveloped insecticide DDT (dichloro-diphenyl-trichloroethane) has indi-ated distinct promise under experimental application to potatoes and other rops. When it becomes available in quantity after the war, it may supplant

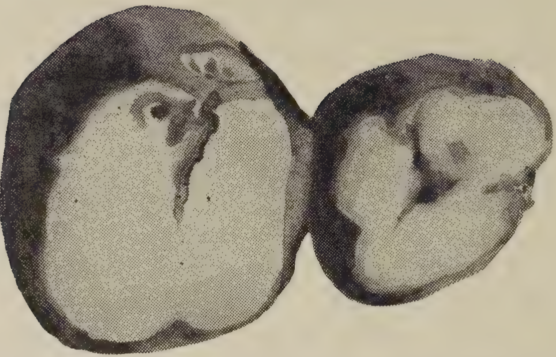

Figure 11.—Injury to potato by wireworms. Tubers cut open to show tunnels made by wireworms.

many insecticides now widely used. Because of its toxic effect on other than injurious insects, this powerful insecticide cannot be used indiscriminately.

14. DISEASES.—*a. Soft rot.*—Generally, soft rot in potatoes is induced either by organisms which attack live potato tissues, or by parasites living on bacteria which, themselves, do not attack live tissue. No vegetable crop is free from these organisms. Bacteria reach the potato tuber either directly from the soil or during packing. Since all of these organisms attack tissues through breaks in the skin, nearly all soft rots result from mechanical injuries, freezing, or aging. The area of decay is usually white to cream-colored, with occasional browning at the margins. Upon exposure to air and light it may become brown to black. The affected tissues are soft and elastic, making the boundary between the soft disintegrating tissues and the sound firm tissues very sharp. The bacterial soft rots are frequently accompanied by foul odors. This condition is most frequently found in the immature early southern crop, particularly when badly bruised or skinned potatoes are loaded while hot or wet, and shipped with poor ventilation. The rot may be spread in transit or storage by contact or by oozing and dripping from decayed tissues. The control of this disease begins in the field. The use of seed potatoes derived from resistant parent stock, crop rotation, and careful sorting during grading and sacking are standard control measures; ventilation with relative humidities below 80 percent and low temperature during transit and storage are additional important factors in the control of this rot.

b. Scab.—Common scab, which is recognizable by the presence of rough pitted spots on the potatoes, is caused by a disease organism that lives in the soil. This organism remains in the soil from year to year. It is also carried on the potatoes intended for use as seed. The disease can be controlled in the field by careful treatment of the soil which produced the scabby potatoes. Scab-free seed potatoes should be used. Just before being cut, the potatoes to be used for seed should be treated with a solution of formaldehyde, mercuric chloride, corrosive sublimate, or organic mercury compounds. Regulation of soil acidity will also control scab.

c. Early blight.—Early blight, technically known as Alternaria tuber rot, usually appears in July or August in the Southern States, causing dark, irregular spots with characteristic target-board markings on the leaves of the plant. The damage to the tuber shows as a yellowish discoloration of the flesh and a corky layer on the surface. Moist warm weather is most favorable for the development of early blight. The disease can be controlled by spraying the plants periodically with Bordeaux mixture.

d. Late blight.—In the earliest stages of late blight the disease on the tubers is marked by reddish-brown or purplish-brown spots which gradually become shrunken and darker in color. In storage, the area becomes firm or leathery and does not usually extend more than one-fourth of an inch beneath the skin; however, in the early southern crop the decay may penetrate to a depth of one-half inch or more. This disease opens the way for bacteria and other organisms which will further rot the tuber. On the leaves and stems of the plant irregular dead areas are found. Under moist conditions, and at storage temperatures above 40° F. the disease spreads rapidly. Under those conditions a wet rot develops and juice from the infected tubers spreads to uninfected tubers. In this manner an entire vine of potatoes may be lost from blight rot. The disease, like early blight, may be controlled with Bordeaux mixture. Potatoes in storage or in transit should be kept dry, well-ventilated, and at temperatures between 35° and 40° F. for control of late blight.

e. Virus diseases.—The so-called "running out" or "off-shape" of potatoes is due mainly to the presence of virus diseases such as spindle tuber, which causes greatly reduced yields. Spindle tubers are characteristically spindle-shaped or cylindrical, the ends being abnormally long and pointed. These diseases, commonly spread by insects such as aphids, are also carried with the seed but cannot be controlled by any form of seed treatment known at present. The planting of seed potatoes that have been grown under inspection and that are sold under a State certification tag is the growers' only safeguard against loss through virus diseases.

f. Net necrosis.—This disease is caused by several factors, including leaf roll. It resembles freezing necrosis in effect in that an intricate network of brown strands is scattered throughout the tuber. However, in net necrosis these strands are not localized as they are in freezing necrosis. Control is accomplished by the use of carefully selected seed.

g. Blackheart.—This disease is caused by suboxidation and may occur either in storage or in transit. The center of the potato becomes jet black, soft, and moist. Occasionally, there is a black ring surrounded by a grayish area. A potato with blackheart is useless. Temperatures of 90° to 140° F. are conducive to blackheart because at high temperatures the respiration of the tubers increases and a larger amount of air is required. But even at low temperatures, poor air circulation in storage bins causes blackheart. This disease does not spread from one tuber to another by contact unless mold or bacterial decay sets in and the oxidation of the tissues reaches the surface. Blackheart may also be caused by freezing. Blackheart may be controlled by storage at a temperature below 95° F. and by good ventilation.

h. Other diseases.—There are many other diseases such as hollow heart, leak, fusarium rots, and rhizopus rots.

15. PHYSICAL INJURIES.—*a. Contact with salt.*—If potatoes come in contact with the floors or walls of a car or storeroom in which salt or salted products, fertilizers, etc., have previously been stored, the tissues of the potato at the point of contact become blackened and shrivel because salt extracts water from the tissue and kills the affected portions. Thorough cleaning of storerooms which have previously contained salt or salted products will prevent this blackening.

b. Transit bruising.—(1) A common method of loading sacked potatoes in cars is to pile them, five or six bags high, on their sides. Another method is to stand the first layer of bags on end and then place two or three layers of bags on their sides over them. The pressure thus exerted on the potatoes next to the floor may range from 200 to 300 pounds per square foot. The amount of bruising injury caused by this pressure depends not only on the jolting of the tubers in transit but also on the condition of the potatoes as influenced by their treatment subsequent to harvesting. Much bruising occurs to newly dug early potatoes in transit. Most of the early potatoes are more or less immature when dug; the tissues are therefore quite turgid and fragile and the skins very tender and easily broken.

(2) Floor bruising of potatoes can be identified by a flattening and softening of the areas in contact with the floor or floor racks and by the fact that such areas usually show the imprint of the bag and generally are moist. The bruised tissues are subject to attack by microorganisms, with resulting rot and decay.

(3) Since transit bruising will occur to both new and old potatoes, it is a common practice to cover the floor racks with building paper, straw, or burlap, to minimize the jolting and pressure that might occur from the floor racks.

(4) Bruising of potatoes may also develop in harvesting, grading, and

toring. Therefore, the utmost care should be taken in all handling of potaoes to reduce the possibility of bruising and subsequent deterioration nd decay (see fig. 12).

igure 12.—Potato bruises widen in storage. The potato at the left might have assed inspection as "a minor bruise" when the injury was fresh. The potato at the right would have been classified as "a major bruise".

c. Cuts.—Digging and rough handling of potatoes frequently cause reaks or cuts which necessitate excessive trimming. These potatoes if tored under warm temperatures will rot. Such potatoes are unfit for baking or boiling with their jackets.

d. Freezing injury.—Investigations show that the freezing point of the otato lies between 29° and 28° F. Freezing may cause large losses ecause every frosted potato in bulk storage may spread discoloration or ot, affecting from a peck to 10 bushels of adjoining potatoes. Symptoms f freezing injury are usually first apparent near the stem, and hence the ost convenient method whereby to determine the presence of freezing njury is to slice off a portion of the stem end.

(1) Freezing injury falls into three general types, depending on the everity of the freeze:

(a) Slight.—Ring-type in which only areas near the surface are disolored black.

(b) Medium.—Net-type in which threadlike bluish-gray discolorations with radiating lines are found in patches throughout the flesh.

(c) Severe.—Blotched-type in which distinct brown or black areas are

present. Sometimes the tuber is soggy and the interior has a water-soaked appearance.

(2) In two ways, freezing may cause blackheart by flooding the intercellular spaces with tuber fluid. First, since ice is formed in needlelike crystals, the cell walls are punctured during the freezing process. When the potato thaws, the cell contents flow into the intercellular regions. Second, the tuber fluids may be exuded into these spaces as the potato cools, and once there, freeze. In both instances, much of the fluid remains outside the cells upon thawing. As a result, the tuber softens, shrivels, discolors, and acquires a bittersweet taste.

(3) Excessive sugar content may result from freezing. Though at low temperatures the diastase continues to break down starches, the respiration of the tuber is slowed down to such an extent that the sugar content increases, and a sweet taste results. To regain the normal sugar balance, the potatoes should be thawed very slowly. After 3 weeks of storage at 60° F., the normal sugar balance is again reached and the sweet taste disappears.

(4) Freezing injury may be aggravated through sudden jars in handling. This is due in part to the weakened condition of the cell walls and the pressure of the fluids outside of the cells. Handling frozen potatoes, therefore, should be avoided. Potatoes which have been frozen for only a short period can be saved by slow thawing at relatively low temperatures.

(5) Freezing may not injure all the potatoes in a bin. Usually when potatoes have been subjected to freezing temperatures for short periods of time, only the outer layers in the bin are injured. The heat of respiration usually helps protect the under layers.

16. PHYSIOLOGICAL DEFECTS.—There are many conditions of potatoes in storage which appear to be brought about by parasitic organisms, but which are actually caused by physical changes in the tuber itself. The most common ones are as follows:

a. Hollow heart.—This condition is produced by too rapid growth. Though the outside of the tuber appears normal, brown, corky, glossy tissues develop around a hollow center.

b. Second growth.—Second growth is caused by favorable conditions in late stages of growth which were preceded by dry conditions during early stages. This second growth is distinguishable by the presence of small knobs on the surface of the potato. Occasionally, irregular growth conditions cause cracks in the tuber.

c. Internal brown spot.—Internal brown spot is caused by dry soils or lack of water at some period during growth. The flesh is speckled with small or large rusty patches scattered throughout the tuber, but these atches do not produce rot. There are no external symptoms whatever, but ternal brown spot affects marketability once its presence in a lot is etected.

d. Sunscald.—If freshly dug potatoes are exposed to strong sunlight r 2 or 3 hours, they may blister. These blisters may soon become de- ressed or bleached and a very irregular margin, dark in color, appears. issues beneath these areas are soft, watery, dull gray, and separated from ninjured tissues by an irregular brown line. This dead tissue is subject attacks by bacteria. Occasionally, however, there are no external ymptoms.

e. Greening.—Greening of the tissues of the potato results from exposure light, either in the field, or in the storage house. It is found more com- only in immature than in fully mature potatoes. The affected portions re bitter, and in severe cases may be poisonous, necessitating either rejec- on or extremely careful trimming.

f. Immaturity.—When the crop is dug before the vines are mature, e potatoes are immature. The skin is thinner than that of a mature otato and easily rubs off or peels. Immature potatoes wilt easily and ecome flabby. The ease with which the skin rubs off makes the potato specially subject to infection by fungous or bacterial organisms.

g. Sprouting.—The most difficult time to obtain a satisfactory potato during the months from April to July. If improperly stored, the old otato is inclined to be shriveled and flabby, and to have a slight bitterness f taste. This condition results from loss of food through respiration during e winter. As the weather becomes warm, the tubers begin to sprout. he sprout grows at the expense of the food stored in the potato and causes distinct loss in food value. If sprouting has not advanced too far, the otatoes can be cleaned; but the purchaser should take great care not to ccept deliveries that show sprouting to any extent. It frequently happens at stocks are purchased which have been cleaned of sprouts.

POTATOES AS FOOD

17. NUTRITIVE VALUE.—*a. Mineral value.*—Potatoes may be used frequently in the diet without objectionable monotony because of their bland flavor and the varied methods of their preparation. It is fortunate that this is the case, for the energy value of the potato is approximately the same as that of bread and in addition the potato is a better balanced food than bread with respect to phosphorus, iron, and vitamins.

b. Vitamin value.—Potatoes contribute only a small amount of vitamin A, although more than does white bread; they supply much more vitamin B than do milled cereals; and they contain vitamin C equal in amount to that of bananas or apples, about one-fourth as much as that of oranges or lemons, and one-half that of tomatoes. Undoubtedly, potatoes aid greatly in protecting a large portion of the population of the United States from scurvy.

c. Nature of fiber.—The fiber of the potato, which softens under any method of cooking, constitutes less than one-half percent of the edible portion, and is almost completely digested and absorbed.

18. FACTORS AFFECTING PREPARATION.—In selecting potatoes for cooking, careful consideration must be given to their cooking quality and the amount of waste involved in preparation.

a. Waste in preparation.—The size, eye depth, and defects of the potatoes largely determine the amount of waste in preparation.

(1) The significance of potato size in determining waste in preparation can be illustrated by two potatoes, one weighing twice as much as the other, but of similar shape and eye depth. The first potato, weighing 4 ounces, will show a peeling loss of 9.8 percent. The second potato, weighing 8 ounces (twice the size of the first potato), will show a peeling loss of only 7.8 percent, or about one-fifth less in proportion to the size of the potato.

(2) Eye depth may have a marked effect on preparation waste. In the case of the deep-eyed varieties, 18 percent of the total waste may be due to removal of eyes, whereas in shallow-eyed varieties, as little as 5 percent of the total waste may be due to eye removal. The use of the Army-type abrasive vegetable peeler to remove eyes of deep-eyed varieties results in a much higher percentage of loss.

(3) Defects in potatoes such as knobs, cuts, bruises, and disease cause losses up to 100 percent. Commonly observed defects are shown as follows:

Defect	*Appearance*	*Cause*
Growth cracks	Blackened cracks	Favorable growing conditions followed by unfavorable weather
Knobs	Small knobs attached	Alternation of extreme weather conditions
Bruises and cuts	Softened, blackened areas or blackened cuts	Potato diggers, rough handling
Insects	Holes on surface, rot inside etc.	Wireworm, Colorado potato beetle
Scab	Dark scab on surface	Microorganisms
Rot	Soft, wrinkled, black interior	Poor storage, microorganism infection, freezing

(4) Naturally, when the absence of defects permits the potato to be cooked in its jacket, there is no waste. But the jacket (or periderm) is composed almost entirely of indigestible corky material which many people find unpalatable or too harsh for the alimentary tract. By cooking in the jacket, this portion can later be removed with a minimum of waste.

b. *Cooking quality.*—The palatability of cooked potatoes, here referred to as cooking quality, can best be understood by first examining the changes brought about by cooking.

(1) Cooking causes the pectin present between the cells to lose its adhesive power, and the cell walls to deteriorate, with the result that the potato softens and falls to pieces.

(2) The starch granules present in the cells are resistant to cold water but will swell noticeably in warm water. This reduces the hardness of the potato.

(3) Cooking decreases the crispness and toughness of texture by softening the fiber which is present in the cell walls. In this softened condition the fiber is more easily digested than it is in the raw product.

(4) In baking and frying, the temperature is high enough to caramelize the sugars. Caramelization is evident from the color, which varies from yellow to dark brown depending on both the temperature and the amount of sugar present. Excessive caramelization produces objectionable burned flavors.

c. *Determining cooking quality.*—Cooking quality is judged by texture, cohesion, and color.

(1) *Texture.*—By texture is meant the relative mealiness of the potato.

(a) Mealy potatoes are those which, when mashed, disintegrate into a loose mass of glistening particles. Americans generally prefer a mealy potato, especially for boiling, mashing, or baking. To be mealy a potato

must be high in starch. The mealiness of potatoes may be determined by rubbing the two surfaces of a cut raw potato together. The greater the quality of starch, the whiter and more dense will be the froth. An additional test is to press the two surfaces together firmly. If they adhere, the potato is a mealy variety. The amount of mealiness is probably directly related to the amount of pectin between the cell walls, which, when cooked, causes disintegration of the cells. However, the real causes for relative mealiness are undetermined. There are no general external characteristics of the raw vegetable which can be safely used to predict the degree of mealiness of the cooked product. But it may be assumed that cultural factors—such as temperature, rainfall, soil acidity and fertility, conditions of storage, and cooking techniques—all influence mealiness. High cooking temperatures and partial drying after cooking appear to be favorable. Baking is superior to boiling as far as producing mealiness is concerned.

(b) Waxy potatoes form cohesive masses of starchy lumps which, though somewhat translucent, do not glisten. The framework of protein in the waxy type prevents the formation of flaky masses of starch. Although not preferred for baking or boiling, waxy potatoes are suitable for salads and for frying.

(c) Soggy potatoes are comparatively low in starch and comparatively high in protein. The protein tends to coagulate and the starch, when swollen, is not of sufficient volume to burst the cell wall. Consequently, the cooked product absorbs water and tends to be soggy. The flesh is heavy and dark.

(2) *Cohesion.*—The tendency of potatoes to resist falling to pieces or sloughing while being boiled is called cohesion. Although cohesion may seem to be the opposite quality of mealiness, it is common to find mealy potatoes which have a high cohesive tendency. Longer storage helps to increase cohesion.

(3) *Color.*—Desirable color is inherent in the potato itself. Three color changes are brought about by cooking:

(a) Iron salts in certain hard waters will develop yellow, green, and brown colors in the potato during the process of boiling.

(b) Peeled potatoes darken upon exposure to air. This is due to oxidation and can be prevented by keeping the raw potato under water, preferably salted with 3 percent or less salt.

(c) Caramelization of sugar, particularly by frying, produces a brown color. The sugar content should be low for the best color, flavor, and mealiness. It should be noted that the sugar content increases with storage at a temperature of 40° F. or less, and potatoes, baked or boiled after such

storage, are inclined to be soggy or watery with a distinctly yellow color and sweet flavor.

d. Desirable cooking qualities.—(1) Generally speaking, the desirable cooking qualities include the following: a high degree of mealiness and cohesiveness; a snowy white color when boiled or mashed; a faint-golden color when baked; a light-golden color when fried; and a characteristic mild flavor.

(2) The frying of potatoes for chips or French fried requires a potato of low sugar content. As the sugar in potatoes increases, the desirable range for frying temperatures becomes narrower and lower, and with lower frying temperature fat absorption increases. With large amounts of sugar, the potato blackens before it is cooked to the desirable crispness.

e. Cooking quality test.—The following is a suggested test for the determination of cooking quality: Select three or four potatoes as nearly uniform in shape and size as possible from each of several different lots. Starting at the same time, boil the potatoes of each lot separately in pans of the same shape and size. Skin all but one potato of each lot at once. Mash them to determine firmness of flesh, color, general appearance, and pleasantness of taste. No seasoning should be used. The remaining potatoes should be allowed to cool. They should then be rewarmed, and judged in a similar manner to determine how they retain their good qualities. A baking test may be made in a similar manner. The potatoes should be baked in an oven at 380° F. The following score card may be used:

Qualification	*Percent*
Ease of cooking (length of time required, etc.)	5
Uniformity of cooked product	10
Lack of breaks in skin and flesh when cooked	10
Texture	10
Color of mashed product (snowy white)	10
Grain of mashed product	15
Flavor	40

f. Selecting method of preparation.—The type of potato used should determine the manner in which it will be prepared. New potatoes, for example, are preferably cooked in a manner that avoids disclosing their sogginess. They do not bake well because the percentage of protein is greater and the percentage of starch lower than in old potatoes. Upon cooking, the protein coagulates, making the product somewhat soggy. The skin does not harden and has a tendency to feather off. Waxy potatoes, on the other hand, are suitable for salads and for creaming.

19. CONSERVATION IN COOKING.—*a.* Large quantities of vitamins and minerals are lost through overcooking or cooking in a large

amount of water. Some of the vitamins are destroyed by heat while others are dissolved in water. The maximum nutritive value will be retained by not overcooking, by not soaking too long in water, and by the use of small quantities of cooking water.

b. Certain valuable constituents are dissolved and lost when potatoes are boiled. The loss is somewhat limited by the jacket or by the cell walls when the jacket is removed. Steaming potatoes results in less loss than boiling them, and fewer constituents are lost by boiling them whole than by boiling them sliced.

20. RECIPES.—Specific potato recipes may be found in TM 10-405, The Army Cook.

PART IV

ONIONS

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SECTION I

1. SCOPE.—The onion is a member of the lily family. It belongs to the genus *Allium* which includes 250 species, numbered among which are chives, garlic, and leeks. The culture of the onion, its importance as a food, its varieties, and the diseases and injuries to which it is susceptible are described in this text. In addition, the methods of grading, storing, transporting, and marketing the onion come under discussion.

2. ONION PRODUCTION.—Production statistics for foreign countries are listed in table I. The United States is the principal producer; Spain is second; Egypt is third; and Italy is fourth. The principal commercial onion-growing centers in the United States are listed in table II along with corresponding statistics. The following 10 states, given in order, lead in total production: New York, Colorado, Texas, Michigan, Idaho, Oregon, Minnesota, California, Wisconsin, and Washington. Table III shows the production yield per acre and the price fluctuation in dollar value.

TABLE I

ONION PRODUCTION IN PRINCIPAL PRODUCING FOREIGN COUNTRIES, 1938-1943

Country	1938	1939	1940	1941	1942	1943
			(100,000 pounds)			
Australia	412	855	711	701	824	—
Canada	811	936	1,023	960	1,100	865
Chile	—	—	946	980	1,006	—
Egypt	4,314	5,935	5,438	2,223	2,447	3,064
Italy	3,200	3,364	3,430	—	—	—
Mexico	306	348	328	467	551	—
New Zealand	155	180	184	189	233	235
Palestine	253	244	409	404	—	—
Spain	—	10,631	10,724	10,483	—	—

TABLE II

ONION PRODUCTION IN THE UNITED STATES

State	Quantity produced			
	10-year average 1932-41	1942	1943	1944
	(100,000 pounds)			
Early Spring				
Texas	1,697	2,292	1,708	2,683
Late Spring				
Arizona	—	—	36	432
California	234	419	270	451
Louisiana	65	104	81	52
Texas	622	823	462	652
Georgia	33	240	76	63
Early Summer				
California	393	437	242	712
New Mexico	—	—	54	80
Washington	129	191	150	161
Iowa	101	75	48	63
Oklahoma	73	90	40	48
Kentucky	28	20	14	15
Virginia	50	46	57	38
New Jersey	391	308	210	275
Late Summer				
Massachusetts	634	338	258	266
New York	2,897	3,526	2,268	4,125
Pennsylvania	58	61	60	54
Ohio	402	264	155	171
Indiana	684	504	247	210
Illinois	309	341	264	242
Michigan	1,818	1,848	840	1,638
Wisconsin	202	340	285	420
Minnesota	584	920	526	608
Iowa	134	169	90	21
Colorado	1,102	1,998	2,464	3,552
Utah	271	264	300	520
Nevada	34	50	60	125
California	708	1,238	1,505	2,145
Idaho	794	850	858	1,485
Oregon	645	731	1,026	1,375
Washington	310	294	252	273
Arizona	—	—	40	90
Total all States	15,402	18,781	14,946	23,040

TABLE III

ONION YIELDS AND PRICES

State	Yield per acre				Price per sack		
	10-year average 1932-41	1942	1943	1944	10-year average 1932-41	1942	1943
	100-pound sacks				Dollars and cents		
Early Spring							
Texas	37	60	61	38	1.80	1.75	4.45
Late Spring							
Arizona	—	—	120	180	—	—	—
California	154	180	200	205	1.72	2.20	3.45
Louisiana	46	55	45	35	1.66	1.75	3.30
Texas	46	42	28	45	1.65	1.25	3.45
Georgia	63	80	76	55	3.33	1.85	3.80
Early Summer							
California	213	230	285	285	1.21	1.45	3.45
New Mexico	—	—	214	200	—	—	—
Washington	242	255	273	230	.91	1.00	3.00
Iowa	153	150	120	140	1.28	1.95	3.75
Oklahoma	57	45	40	40	1.25	2.00	2.90
Kentucky	115	135	140	150	1.49	1.75	3.70
Virginia	77	48	95	64	1.69	1.95	3.50
New Jersey	128	110	105	125	1.60	2.30	3.50
Late Summer							
Massachusetts	228	250	215	205	1.10	1.85	3.75
New York	238	232	210	275	1.41	2.60	3.60
Pennsylvania	162	170	155	135	1.30	2.65	4.50
Ohio	145	220	180	190	1.40	1.90	3.50
Indiana	166	240	130	150	1.26	2.30	3.80
Illinois	121	155	120	110	1.26	2.00	3.70
Michigan	186	220	150	210	1.30	2.55	3.55
Wisconsin	170	200	150	200	1.12	2.00	3.40
Minnesota	196	215	135	160	1.03	2.30	2.75
Iowa	182	225	200	115	1.06	2.00	2.65
Colorado	206	270	265	245	.98	1.55	2.40
Utah	250	220	250	260	.78	1.50	2.70
Nevada	212	250	200	250	1.12	2.25	3.00
California	179	195	215	220	1.04	2.00	3.35
Idaho	310	250	260	270	.76	1.00	2.15
Oregon	256	215	285	275	1.14	1.65	2.60
Washington	242	280	300	260	.85	1.25	2.65
Arizona	—	—	80	90	—	—	—
General Average	119	140	136	132	1.26	1.99	3.23

3. VARIETIES.—Many varieties of onions are grown in the United States. In general, they may be classified as northern and southern varieties.

a. Northern varieties.—In the northern areas the common varieties grown are: Southport White Globe, Southport Yellow Globe, and Southport Red Globe. Yellow Globe Danvers is grown in the East and Midwest and, in addition, Australian Brown in California. In the Rocky Mountain areas the sweet Spanish varieties are grown extensively. In the midwestern and eastern areas some Ebenezer, Red Wethersfield, White Portugal, and Early Yellow Globe onions are grown from sets. Most of the northern crop is carried in storage for varying periods and is placed on the consuming market throughout the country up to March or April.

b. Southern varieties.—The southern crop is grown in part from northern grown sets of the Ebenezer, Red Wethersfield, and White Portugal varieties. Most of the crop, however, is of the very flat, mild-flavored Bermuda type, chiefly Yellow Bermuda, Crystal Wax and, to a limited extent, the pungent Red Creole. The southern crops mature in April and May and thus supply the consuming markets throughout the country during April, May, June, and July. These are followed by the earliest northern onions grown from sets. The Bermuda type is not adapted to long storage, and the marketing season of this crop is much shorter than that of the northern crop.

c. Varietal characteristics.—The more common varieties of onions grown in the United States, together with their distinguishing characteristics, are listed in table IV.

4. IMPORTANCE AS A FOOD.—*a. Comparative popularity.*—The onion is used both as a vegetable and a seasoning agent. It ranks fifth among all vegetables in the amount eaten. The average annual consumption is 16.6 pounds a person. The following quantities of vegetables were consumed in the United States in 1942:

Potatoes, Irish	20,245,022,000	pounds
Tomatoes	10,345,154,000	pounds
Cabbage	4,141,724,000	pounds
Potatoes, sweet	3,523,677,000	pounds
Onions	3,445,573,000	pounds

b. Edibility.—Assuming, of course, that the purchased onion is sound, approximately 94 percent of it is edible. The loss is a result of peeling and removing stems and roots.

c. Acid contents.—Mature onions are classed as a moderate source of carbohydrates and pantothenic acid, and a poor source of vitamin A and thiamin. Raw, freshly harvested onions contain relatively high concentrations of ascorbic acid, but losses vary from 47 to 80 percent during home storage.

d. Sulfur content.—The characteristic odor and pungency of the onion are due to the presence of an oil, the chief constituent of which is allylpropyl disulfide with small amounts of vinyl-sulfide and polysulfides. The volatile sulfur content is not identical in any one variety when grown in different sections, but it is always less in the mild varieties than in the strong varieties.

e. General composition.—The general composition of the onion is shown in table V, and its mineral and vitamin content in table VI.

f. Cooking characteristics.—Onions are used both as a seasoning or flavoring agent in meat and vegetable mixtures, and as a vegetable which may be boiled, steamed, stewed, or fried. In general, the strong varieties are more satisfactory for seasoning cooked products, and the mild Bermuda type as a vegetable or for a raw seasoning agent in salads. Like most plant foods, onions vary in composition, in mineral content, and in vitamin value. The amount of disparity depends upon such factors as variety, maturity, soil, climate, and method of preparation. When cooked, the values will be considerably lower because of the dilution with cooking water, the discard of cooking liquid containing soluble nutrients, and the destruction of vitamins through heat or oxidation in the cooking process. Varieties which are classed as strong or weak when raw are classed the same when cooked. Approximately half the volatile sulfur present in the raw onion is lost during the cooking process. Cooking until just tender in an open kettle is the recommended method for boiled onions. Onions lose approximately 27 percent of their ascorbic acid content after 5 minutes of boiling.

TABLE IV

DISTINGUISHING CHARACTERISTICS OF ONION VARIETIES GROWN IN THE UNITED STATES

Variety	Season of maturity	General shape of mature bulb	Color of dry bulb scales	Solidity or firmness	Flavor
Australian Brown	Midseason to late	Oblate	Brown	Hard	Very strong
Brigham Yellow Globe	Midseason to late	Round to oval	Deep purple	Medium to hard	Strong
California Early Red	Second early	Thick flat	Purplish red	Soft	Very mild
Crystal Wax	Early	Thick flat	White	Soft	Mild
Early Grano	Early	Ovate	Pale yellow	Soft	Very mild
Early Yellow Globe	Second early	Deep oblate	Medium yellow	Medium	Strong
Ebenezer	Second early	Oblate	Pinkish yellow	Medium to hard	Very strong
Italian Red	Midseason to late	Torpedo	Purplish red	Soft	Very mild
Mountain Danvers	Second early	Deep oblate	Brownish yellow	Medium	Strong
Ohio Yellow Globe	Midseason	Obovate	Brownish yellow	Medium	Strong
Red Creole	Early	Thick flat to oblate	Buff red	Hard	Very strong
Red Wethersfield	Midseason to late	Thick flat	Purplish red	Soft to medium	Strong
Southport Red Globe	Midseason to late	Round to oval	Purplish red	Medium to hard	Strong
Southport White Globe	Midseason	Oblate to round	White	Medium to hard	Strong
Southport Yellow Globe	Midseason to late	Round to oval	Medium yellow	Medium to hard	Strong
Sweet Spanish	Late	Round	Brownish yellow	Medium	Mild
White Creole	Early	Thick flat to oblate	White	Hard	Very strong
White Portugal	Late	Oblate	White	Medium to hard	Very strong
White Sweet Spanish	Late	Deep oblate to round	White	Medium	Mild
Yellow Bermuda	Early	Thick flat	Pale yellow	Soft	Mild
Yellow Globe Danvers	Midseason	Deep oblate to round	Brownish yellow	Medium to hard	Strong

TABLE V

PERCENTAGE OF VARIOUS NUTRIENTS IN EDIBLE PORTION OF FRESH AND PROCESSED ONIONS

Type	Water (grams)	Carbohydrates other than fiber (grams)	Sugar (grams)	Protein (grams)	Fat (grams)	Crude fiber (grams)	Ash (grams)
Fresh (fresh basis)	87.5 87.5	— 9.5	8.7 —	— 1.4	— 0.2	0.5 0.8	0.5 0.6
Boiled (fresh basis)	91-92	2.7	6.1	0.6	—	—	—
Fried (fresh basis)	40-45	—	10.1	1.8	33.0	—	—
Dehydrated (moisture-free basis)	4.0	—	70.0	—	—	4.0	4.0

TABLE VI

MINERAL AND VITAMIN CONTENT OF THE ONION

(Amount in 100 grams edible portion)

Type	Calcium (mgs)	Phosphorus (mgs)	Iron (mgs)	Copper (mgs)	Volatile sulfur (mgs)	Vitamin A I.U. (mgs)	Ascorbic acid (mgs)	Thiamin (mgs)	Riboflavin (mgs)	Niacin (mgs)	Pantothenic acid (mgs)
Fresh (fresh basis)	26 34	26 45	.48	— .08	6.3-20.0	— 280	7 4-9.6 22	.053 .033 .04-.05	.011 .012 .01-.02	.07-.22	.13-17
Boiled (fresh basis)	24	16	.25	.07	2.3-9.9	—	16	.065	.014	—	—
Fried (fresh basis)	6	59	.59	.16	—	—	—	—	—	—	—
Dehydrated (moisture-free basis)	260	260	—	—	45.3-110.0	—	22-52 24-40	.2-.4 .25-.34	0.1-0.2 .08-.11	0.6-1.3 —	— .5-1.2

SECTION II

CULTURE OF ONIONS

5. CLIMATE.—For best development, onions require cool weather early in the growing season, and subsequently, a dry atmosphere and moderately high temperature. The growing season varies for the different producing areas. In the southern part of the United States, the growing season is during the late autumn and winter, the crop maturing in the spring and early summer. In the northern sections, the growing season is late winter and early spring, the crop maturing in late summer or early autumn.

6. SOIL.—A suitable soil is of fundamental importance. For this crop, the soil should retain sufficient moisture about the roots and at the same time be friable enough to cultivate easily and to allow the bulbs to expand properly. It should be fertile, well supplied with humus, and relatively free from weed seeds. The onion crop is grown mainly on sandy loams, silty loams, and peat and much soil. Heavy clay and coarse sand or gravel should be avoided.

7. PLANTING.—Most of the onions grown in the United States are started from seed by being sown at the rate of 3 to 5 pounds per acre in the rows where the crop is to grow. In some cases the seed is sown in beds and the seedlings then transplanted to the open ground. Practically the entire crop of Bermuda-type onions grown in the United States is handled by the transplanting process. The objects gained by transplanting are: an earlier crop, a uniform stand, and bulbs of more regular size. In some sections of the country, sets are grown from seed and then planted in the field the next season to produce mature bulbs. The Red Wethersfield, Ebenezer, and White Portugal varieties are grown chiefly from sets. They are widely distributed and used generally for spring bunching onions in the home garden and on the commercial truck farm. Onions grown from sets will ripen earlier than those grown from seed in the field, but the use of sets for commercial onion growing is not so practicable because of their high cost.

8. MOISTURE.—The onion is among the most shallow-rooted of the vegetable plants. During early growth it requires abundant surface soil moisture. The plants will stand an excessive amount of water with less injury than they will a deficient supply. New roots are not formed unless the zone from which they arise is in moist earth. The plant must be kept growing. If growth is checked temporarily by shortage of water, the outer scales seem to mature; when water is again supplied, the inner scales resume growth, causing the outer ones to split. This is the main cause of "splits" and "doubles" where onions are grown under irrigated condi-

tions. From the time the crop begins to mature until it is harvested, the amount of soil moisture necessary is less than during the earlier stages of growth. An oversupply during this period is undesirable because it may make the onions watery and impair their keeping quality.

9. FERTILIZATION.—Since the onion plant is shallow-rooted, a fairly high concentration of soil nutrients must be maintained in the upper foot of the soil. Manure is important in growing onions on "mineral" soils. From 15 to 20 tons per acre is considered sufficient. On many soils manure should be supplemented by commercial fertilizer. Where manure is not used, equally good results may be obtained with commercial fertilizer alone, the type and amount depending on the type of soil.

10. TEMPERATURE AND PHOTOPERIOD.—Proper temperature and long exposure to light are necessary for onion-bulb formation. Onions planted in the fall or winter grow a heavy foliage, but the bulbs do not form until spring when longer days and higher temperatures aid bulb formation. A certain number of hours of light each day is necessary for this purpose. The minimum day-length for bulb formation varies for the different varieties and is affected by the growing temperature. Temperatures between 50° and 60° F. retard bulb formation, and between 70° and 80° greatly accelerate it at favorable day-lengths. The attainment of maturity, that is, the cessation of new foliage and root growth with the subsequent softening, shriveling, and collapse of the tissues of the neck and death of the roots, usually requires a longer day-length than does the start of the bulb formation. Increased day-lengths hasten maturity, whereas low temperatures, after bulb formation has started, delay maturity. The shortest photoperiods required to produce 100 percent normal bulbs in the different varieties and strains are shown in table VII.

TABLE VII

PHOTOPERIODS REQUIRED TO PRODUCE NORMAL BULBS

12 hours	13 hours	13.5 hours	14 hours	14.25 hours
Early Grano Yellow Bermuda White Creole	California Early Red Ebenezer Yellow Danvers Flat Yellow Strasburg	Australian Brown Early Yellow Globe Mountain Danvers Ohio Yellow Globe Southport Yellow Globe Sweet Spanish (strain 1) White Portugal	Italian Red Red Wethersfield Southport Red Globe	Yellow Globe Danvers

SECTION III

INSECTS, DISEASES AND INJURIES

11. GENERAL.—Onions are susceptible to diseases, insect attacks, and mechanical injuries. Some diseases originate both in the field and in storage; some occur only in storage; while others appear in the field and spread in storage. Those damages that affect the grade, the transportation, or storage of the bulbs, or their use, are here briefly described; but not those that affect the growing plants unless they carry over into storage. Environmental factors such as climatic conditions and type of soil have a direct bearing upon the diseases and the insect infestations.

12. INSECTS.—*a. Thrips.*—Onion thrips are small whitish or brownish insects which feed in large numbers on the leaves and cause injury. The insects often completely destroy large fields of onions and are particularly prevalent in the South. Thrips are a constant menace to the Texas Bermuda crop.

b. Maggot.—The onion maggot is the most harmful of the northern onion pests. It eats into the bulb and starts decay which often destroys the whole onion. The onion maggot is the larva of a small gray fly which looks like a housefly.

c. Red spiders.—In dry years red spiders similar to onion thrips feed on the leaves and cause injury. Late onions are most often attacked.

13. MOLDS.—*a. Black mold rot.*—Black mold rot, caused by the *Asperigillus,* occurs on all onion varieties and in all sections of the country; it is most serious in Louisiana, Texas, and California, and is particularly conspicuous on white varieties. The chief sign of this disease is the presence of black powdery spore masses on the outside scale or between that and the next inner one. Its main distinguishing characteristic is the fact that the black powdery masses of spores are borne on the exterior of the scales and can be rubbed off easily. Black mold causes a slow shriveling of the affected scale which takes on a brittle texture. Growers and dealers often confuse black mold and onion smut because of a similarity in appearance.

b. Smut.—This disease, caused by the *Urocystis cepulae,* occurs in most of the northern onion-growing sections including New York, New Jersey, Ohio, Wisconsin, Illinois, Iowa, and Oregon. It is not a factor in the winter-growing southern sections. The bulbs of affected onions are usually so small that they cannot be marketed, although occasionally they grow large enough to sell. The disease appears as dark-colored, slightly raised streaks or blisters. These blisters or pustules are most

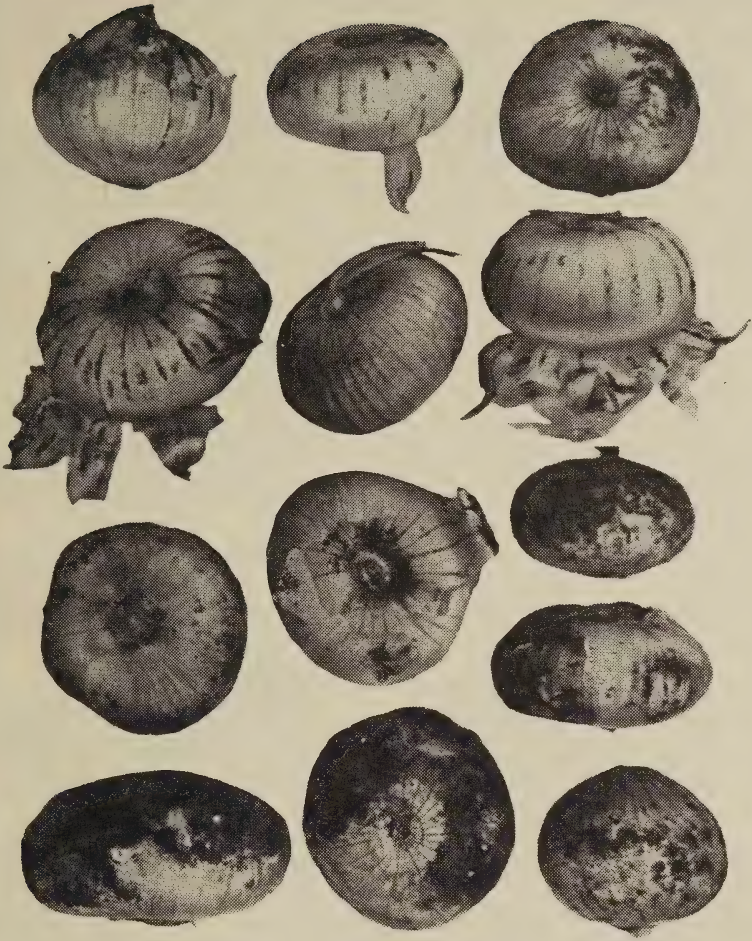

Figure 1.—Onion black mold.

prevalent near the base of the outer fleshy scale but may sometimes occur as deep as the third or fourth scale. They are filled with greenish-black powdery masses of spores. Smut does not cause a storage rot but smutted bulbs shrink more rapidly than healthy ones and are more susceptible to the attack of other organisms.

c. Smudge.—Onion smudge, caused by the *Colletotrichum circinans,* is confined largely to white varieties. It appears in the field just before harvesttime and continues to develop during storage. It is characterized by small, dark-green to black dots on the outer scales. The dots may be grouped together in various ways and are often arranged in concentric rings which give the white bulbs a smudgy, unsightly appearance. In severe cases the smudgy spots are so extensive that the side of the onion looks smoked. Usually the lesions are on the outer scales but they may be on the inner ones as well. On fleshy scales the fungus produces sunken, yellowish spots that enlarge slowly.

d. Gray mold neck rot.—This rot, caused by the *Botrytis* genus, is closely related to the common gray molds that attack lettuce, cabbage, and numerous other vegetables. Neck rot is one of the most destructive diseases of onions following harvesting and during transit and storage. All varieties are susceptible to this disease but the white ones are the most seriously affected. Infection usually takes place through the neck tissues of the bulbs although it may frequently occur through bruises. The first indication is a softening and water-soaking of affected scales which soon become grayish and finally grayish brown. Later a dense layer of white to grayish mold develops over the surface of the affected region, forming laterally from the point of infection as well as down through the fleshy scales. No odor accompanies the decay.

e. Fusarium bulb rot.—This rot is caused by the *Fusarium* genus. It has been reported from practically all onion-growing sections of the United States and is especially severe in the warmer sections. On the market it has been found serious in shipments from Ohio, Illinois, Wisconsin, Colorado, California, and Washington. Onions affected with Fusarium bulb rot show a dense growth of white to pinkish mold at the base and, in severe cases, the bulb may show a semiwatery, mealy, or dry decay which progresses upward along the scales from the base.

f. Pink root.—Pink root, caused by the *Phoma terrestris,* is common to many onion-growing sections. The greatest damage occurs in the Texas, Louisiana, Iowa, and California crops. Although primarily a field disease, it is of market importance because it causes a reduction in the size of the bulbs, and the lesions produced open the way for other organisms that cause decay. The roots of onions affected with pink root are shriveled and discolored, varying from pink to dark red and purple.

g. Purple blotch.—The *Macrosporium porri* causes the purple blotch which is not of great economic importance except under certain weather conditions. Infection occurs at harvesting time, usually at the necks or through bruises. The lesions are semiwatery at first, becoming papery as they dry. The color of the lesion is the most charactertisic symptom. The tissues are yellow at first, later becoming red, then brown, and finally black. Sometimes only one or two outer scales are affected, whereas at other times the entire bulb may be destroyed.

h. White rot.—White rot, caused by the *Sclerotium cepivorum,* is preva-

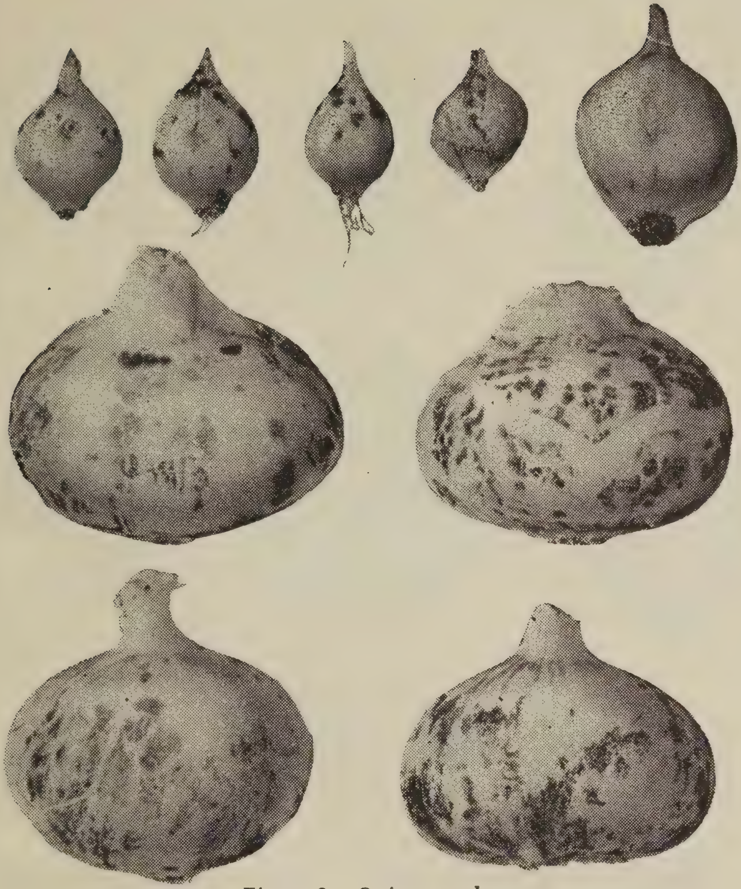

Figure 2.—Onion smudge.

lent in California, Virginia, Kentucky, and New Jersey. The appearance of the diseased bulb is often like that of gray mold neck rot and Fusarium bulb rot, but the mycelium is whiter and more cottony.

14. BACTERIA.—Bacterial soft rot, a disease caused by the *Erwinia carotovora,* occurs in all onion-growing districts in the United States but is most common in onions harvested during warm rainy seasons or in those that develop sunscald during the curing process. It occurs in the field, in transit, and in storage. The affected tissues are glassy or water-soaked at first, later becoming soft and mushy. The rot is usually accompanied by a repulsive sulfurous odor. The bacteria generally enter through the neck, and the decay progresses downward and often is confined to one or two scales in the interior or to the central scales. When this occurs, the only

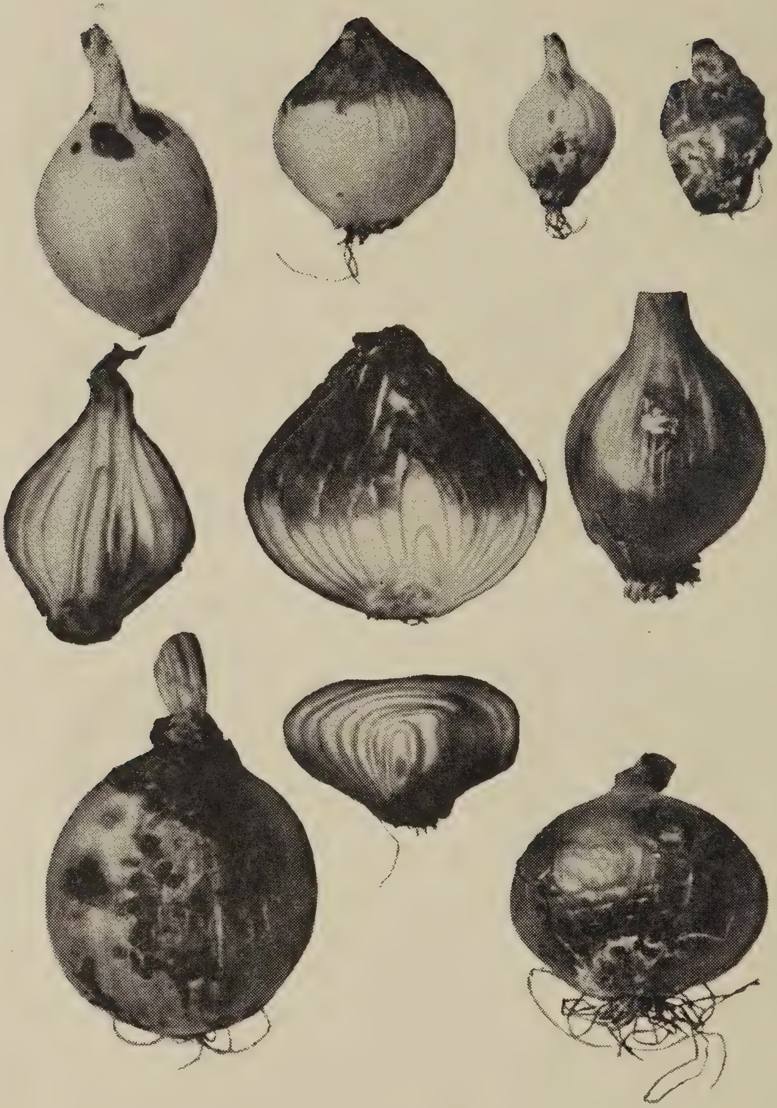

Figure 3.—Onion neck rot.

external sign of the disease is the loss of firmness. Any injury on the onion, such as sunscald, freezing, and bruises caused by careless handling, may open the way for this type of rot. The presence of maggots is common where bacterial soft rot occurs, and it is believed that the maggot serves as a carrier.

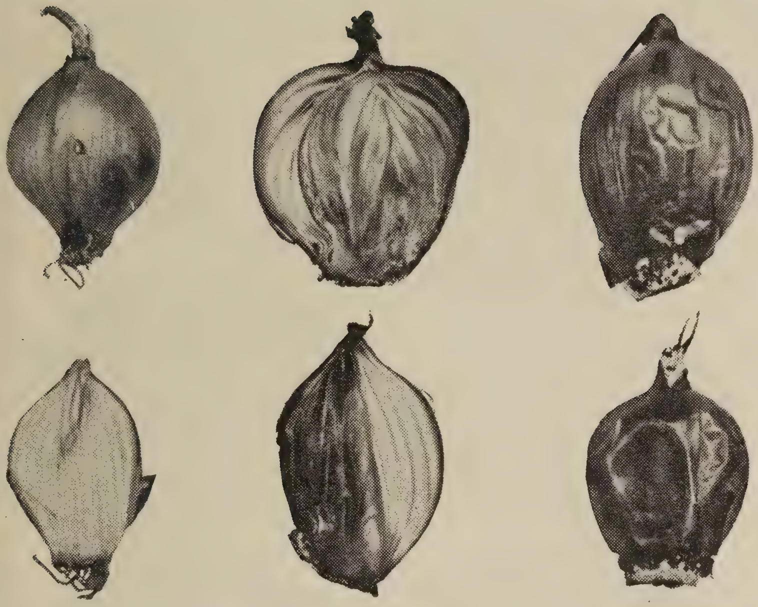

Figure 4.—Onion Fusarium bulb rot.

15. PHYSICAL FACTORS.—*a. Freezing.*—Onion bulbs vary in heir reaction to low temperatures, but most of them will show freezing njury if exposed to an average temperature of 30° F. or below. Onions ffected by freezing injury show water-soaked, grayish-yellow, fleshy scales vhen cut. Irregularly shaped opaque areas occur in many of the watery ransparent scales. Soft rot commonly follows the freezing injury. If the atter is confined to the outer scales, the bulbs can usually be salvaged by eing spread in thin layers and allowed to dry. Frozen bulbs suffer less lamage if they are thawed at 50° F. or above than if thawed slowly at 32° F.

b. Bruising and mechanical damage.—During harvesting and curing, nions are subjected to much handling by both hand and mechanical equipnent. In consequence, they frequently suffer damage in the field, in transit, nd in storage. The open lesions of bruised and mechanically damaged nions facilitate the attack of various organisms that cause decay.

16. PHYSIOLOGICAL FACTORS.—*a. Physiological breakdown.*—Physiological breakdown, the cause of which is unknown, is characterized y a grayish water-soaked appearance of the outer fleshy scales. It is similar o freezing injury except that the bulbs have not been exposed to low temeratures. It differs, too, in that the water-soaked tissues do not always

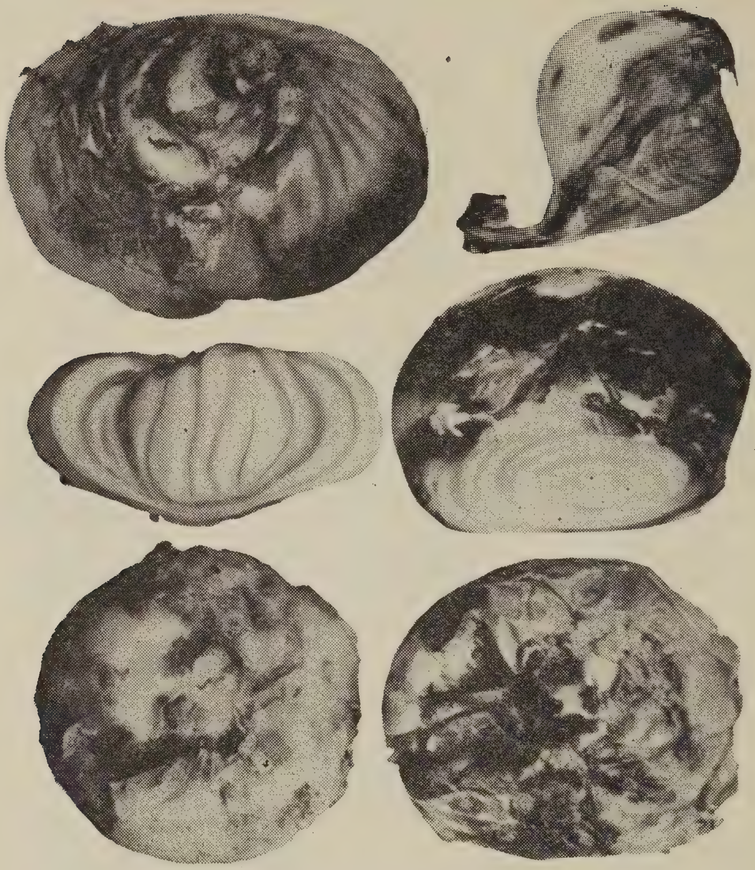

Figure 5.—Onion slimy soft rot.

extend completely around the bulb and in that they do not contain the opaque areas often found in the frozen onions.

b. Sunburn.—Sunburn is caused by exposure of the onion bulbs to moderate light during the growing period or after the harvesting period. Too much sunlight causes a development of green coloring matter in the exposed tissues making them bitter and unpalatable. However, the marketability of the onions, unless the lot as a whole shows prominent blemishes, is not greatly influenced.

c. Sunscald.—Onions grown in regions where the temperature is high and sunlight extremely bright are often severely affected with sunscald at harvesttime. Tissues of the exposed area are killed, become soft and slippery, and then rapidly lose moisture by evaporation. Finally, sunken leatherke areas bleached almost white appear. Various bacteria and other rganisms causing decay may enter through these dead areas. Bacterial soft ot is probably the most important disease that follows sunscald. Sunscald, erefore, has a serious effect on the marketing of onions.

17. MISCELLANEOUS FACTORS.—*a. Immaturity.*—All onions o not mature at the same time. Consequently, at harvesttime some bulbs re pulled while still immature. In some cases, too, climatic conditions do ot favor proper development. The immature bulbs have open and thick ecks, are less solid than fully mature bulbs, and cannot be stored for any ngth of time.

b. Second growth.—Onion plants sometimes suffer a check in growth aused by cold weather, insufficient moisture, and lack of fertilizer. Then, sudden stimulation into active growth through warmer weather, addi- onal fertilizer, and moisture is likely to produce doubles and splits during period known as the "second growth." This is most likely to happen if the heck in growth develops after bulb formation has already begun.

c. Seed stem.—Onions that contain an inedible, tough seed-stalk are alled seeders. They generally result from extended exposure to tempera- ures less than 60° F. Seeders most often occur either in onions grown om sets or from transplants.

d. Chemicals.—Chemicals cause discoloration on colored onions, the ost common of which are the "scorched spot," "alkali spot," and "bag rint" blemishes. The fabric of the bag contains a chemical which, when the ag is moist, produces an alkaline reaction when it comes in contact with the olor pigment of the onion scales. Occasionally, the spots are uniformly ark brown or black, and sometimes the mesh of the bag is distinctly printed n the scales. There is no injury to the underlying fleshy scales, so that the ating qualities of the onion are not impaired. Underlying fleshly scales ay be damaged, however, after any accidental exposure for several hours ammonia, as sometimes happens in cold storage. Yellow onions will then ow a brown discoloration; red onions, a deep greenish-black or metallic- lack color; and white onions, a greenish yellow.

GRADING

18. METHODS.—Grading is done over inclined screens or slatted racks through which the loose tops and dirt pass. There are two sets of grades: one for early or Bermuda onions, and one for the late northern-grown crop. They are similar except for size and allowance for "pink" onions in the case of the Bermuda. The standards for the northern-grown onions, derived from the United States Department of Agriculture, Production and Marketing Administration, follow:

United States Department of Agriculture
Production and Marketing Administration*

U. S. Standard for Northern Grown Onions

(Effective July 17, 1939)
(Reissued August 20, 1943)

GRADES

U. S. No. 1 shall consist of onions of similar varietal characteristics which are mature, fairly firm, fairly well shaped, free from doubles, splits, bottlenecks, scallions, and from damage caused by seedstems, tops, roots, sunscald, sunburn, sprouting, freezing, peeling, dirt, foreign matter, disease, insects, or mechanical or other means. UNLESS OTHERWISE SPECIFIED, the minimum size shall be 1½ inches in diameter, and in the case of yellow, brown, and red onions, 40 percent or more, and in the case of white onions, 30 percent or more, by weight, of the onions in any lot shall be 2 inches or larger in diameter.**

In order to allow for variations other than size, incident to proper grading and handling, not more than 10 percent, by weight, of the onions in any container may be damaged by peeling and not more than 5 percent may be below the remaining requirements of this grade but not more than two-fifths of this tolerance or 2 percent, may be allowed for onions which are affected by decay. In addition, not more than 5 percent, by weight, may be below the minimum size specified and not more than 15 percent may be above any specified maximum size. No part of any tolerance shall be allowed to reduce the percentage of onions which shall be 2 inches or larger in diameter or any other specified size or larger, but individual containers

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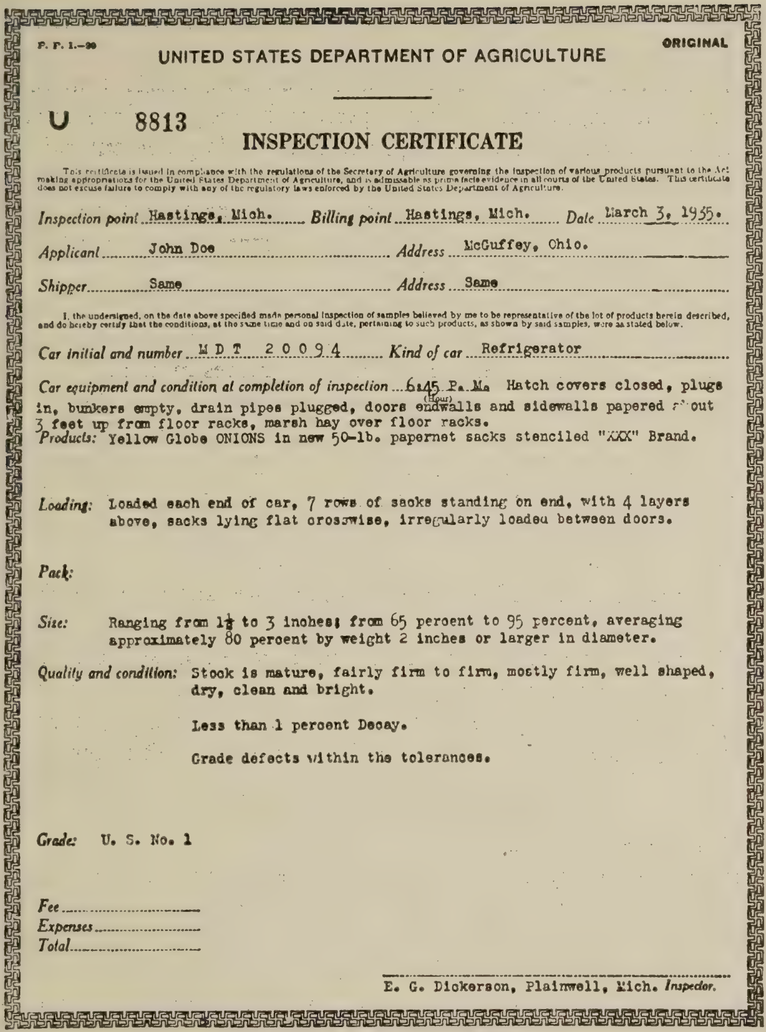
* This is a reissue of U. S. Standards for Northern Grown Onions, which became effective July 17, 1939, formerly issued by the Agricultural Marketing Service. No change is made in the text of these standards.

** Any lot of onions quoted as being of size *smaller* than 1½ inches minimum such as "U. S. No. 1, 1¼ inches min." is not required to meet the percentage which shall be 2 inches or larger as specified in the U. S. No. 1 grade.



F. P. 1.—90

ORIGINAL

UNITED STATES DEPARTMENT OF AGRICULTURE

U 8813

INSPECTION CERTIFICATE

This certificate is issued in compliance with the regulations of the Secretary of Agriculture governing the inspection of various products pursuant to the Act making appropriations for the United States Department of Agriculture, and is admissable as prima facie evidence in all courts of the United States. This certificate does not excuse failure to comply with any of the regulatory laws enforced by the United States Department of Agriculture.

Inspection point Hastings, Mich. Billing point Hastings, Mich. Date March 3, 1955.

Applicant John Doe Address McGuffey, Ohio.

Shipper Same Address Same

I, the undersigned, on the date above specified made personal inspection of samples believed by me to be representative of the lot of products herein described, and do hereby certify that the conditions, at the same time and on said date, pertaining to such products, as shown by said samples, were as stated below.

Car initial and number M D T 2 0 0 9 4 Kind of car Refrigerator

Car equipment and condition at completion of inspection 6:45 P. M. (Hour) Hatch covers closed, plugs in, bunkers empty, drain pipes plugged, doors endwalls and sidewalls papered about 3 feet up from floor racks, marsh hay over floor racks.

Products: Yellow Globe ONIONS in new 50-lb. papernet sacks stenciled "XXX" Brand.

Loading: Loaded each end of car, 7 rows of sacks standing on end, with 4 layers above, sacks lying flat crosswise, irregularly loaded between doors.

Pack:

Size: Ranging from 1½ to 3 inches; from 65 percent to 95 percent, averaging approximately 80 percent by weight 2 inches or larger in diameter.

Quality and condition: Stock is mature, fairly firm to firm, mostly firm, well shaped, dry, clean and bright.

Less than 1 percent Decay.

Grade defects within the tolerances.

Grade: U. S. No. 1

Fee ....

Expenses ....

Total ....

E. G. Dickerson, Plainwell, Mich. *Inspector.*

PLEASE REFER TO THIS CERTIFICATE BY NUMBER

Figure 6.—Inspection certificate.

nay have not more than 25 percent less than the percentage specified, provided that the entire lot averages within the percentage specified.

U. S. Commercial shall consist of onions of similar varietal characteristics which are mature, not soft or spongy, not badly misshapen, free from doubles, splits, bottlenecks, scallions, and from damage caused by seedstems, ops, roots, sunscald, sunburn, sprouting, freezing, disease, insects, or mechanical or other means, and from serious damage by dirt or other foreign matter. UNLESS OTHERWISE SPECIFIED, the minimum size shall be 1½ inches in diameter.

In order to allow for variations other than size, incident to proper grading and handling, not more than 5 percent, by weight, of the onions in any container may be below the requirements of this grade but not more than two-fifths of this tolerance, or 2 percent, may be allowed for onions which are affected by decay. In addition, not more than 5 percent, by weight, may be below the size specified and not more than 15 percent may be above any specified maximum size.

U. S. No. 1 Boilers shall consist of onions which meet all requirements for U. S. No. 1 grade except for size. The size of onions of this grade shall be not less than 1 inch nor more than 1⅝ inches in diameter.

In order to allow for variations other than size, incident to proper grading and handling, not more than 10 percent, by weight, of the onions in any container may be damaged by peeling and not more than 5 percent, by weight, of the onions may be below the remaining requirements of this grade, but not more than two-fifths of this tolerance, or 2 percent, may be allowed for onions which are affected by decay. In addition, not more than 5 percent, by weight, may be below the minimum size, and not more than 15 percent may be above the maximum size specified for this grade.

"Unclassified" shall consist of onions which have not been classified in accordance with any of the foregoing grades. The term "unclassified" is not a grade within the meaning of these standards but is provided as a designation to show that no definite grade has been applied to the lot.

DEFINITIONS OF TERMS

As used in these standards:

"Mature" means dry and well cured. Midseason onions which are not customarily held in storage shall be considered mature when harvested in accordance with good commercial practice at a stage which will not result in the onions becoming soft or spongy.

"Fairly Firm" means that the onion may yield slightly to moderate pressure but is not appreciably soft or spongy.

"Fairly Well Shaped" means having the shape characteristic of the variety but slightly off-type; slightly elongated or slightly misshapen onions shall be admitted to U. S. No. 1 grade.

"Badly Misshapen" means that the onion is so elongated or misshapen that its appearance is seriously affected.

"Doubles" and "Splits" or onions which have developed more than one distinct bulb. All such onions which are either distinctly misshapen or which show a splitting of the dry outer scales shall be excluded from U. S. No. 1.

"Bottlenecks" are onions with abnormally thick necks.

"Scallions" are onions which have thick necks and relatively small and oorly developed bulbs.

"Damage" means any injury from the causes mentioned which materially ffects the appearance of the lot or the edible or shipping quality of the ndividual onions. Any one of the following defects shall be considered as damage":

a. "Sunscald" which affects the shipping or market quality. Slight dry cald which is not readily apparent without peeling the onion shall not e considered as damage.

b. "Peeled" onions when more than one-half of the thin papery skin s missing, leaving the larger portion of the fleshy outer scale unprotected. uch onions are sometimes referred to as "bald" or "skinned" onions, or peelers."

c. Onions which have one or more of the fleshy scales cracked. Such nions are undesirable because of the possibility of decay organisms enterng the injured tissue. Cracking of the thin papery skins shall not be egarded as damaged.

d. Any lot of onions which is materially stained. A lot of onions shall e considered as materially stained when there are enough stained onions o distinctly detract from the appearance of the lot. In this connection he number of stained onions permitted will depend upon the natural color f the onions and upon the degree of staining on individual onions. In lot of yellow, brown, and red onions, 20 percent may be not more than ppreciably stained before the lot is considered damaged but when the nions are badly stained not more than 5 percent shall be permitted. In lot of white onions, 15 percent may be not more than appreciably stained, ut not over 5 percent may be badly stained. These percentages are given s a guide in determining whether or not a lot is out of grade on account f "damage by dirt" and they shall be in addition to the 5 percent tolernce allowed for other defects.

e. "Damage by Tops." In considering this factor the appearance of the ot of onions as a whole should be considered. While all onions should be rimmed to less than 2 inches, there are often some that have been cut vith tops a little longer. However, any lot of onions having more than 20 ercent of onions with tops over 2 inches in length shall be considered as lamaged. This percentage is given only as a guide and it may be reached f the tops are very long. For example, not more than 10 percent of nions may have tops longer than 5 inches.

"Serious Damage by Dirt or other Foreign Matter." Onions shall not e considered seriously damaged by staining unless more than 10 percent f the lot is badly stained.

SECTION V

STORAGE

19. SUITABILITY.—Not all onion varieties are suitable for storage. Bulbs of the varieties comprising the early and midseason crops do not keep well under the most favorable conditions. Table VIII, based on experiment, indicates the storage qualities of the principal American varieties.

TABLE VIII

STORAGE QUALITIES OF PRINCIPAL AMERICAN VARIETIES OF ONIONS

Very poor	Poor	Fair	Good	Very good
Italian Red	California Early Red Crystal Wax Early Grano Yellow Bermuda	Prizetaker Sweet Spanish White Sweet Spanish	Early Yellow Globe Ebenezer Mountain Danvers Ohio Yellow Globe Red Wethersfield Southport White Globe Southport Yellow Globe White Portugal Yellow Danvers Flat Yellow Strasburg Yellow Globe Danvers	Australian Brown Red Creole White Creole

20. GENERAL REQUIREMENTS.—*a. Preparation.*—Onions intended for storage should be well ripened and thoroughly dried or cured. Immature or soft onions with open necks should be eliminated.

b. Containers.—Onions may be stored in bulk, in bins, in 50- or 100-pound sacks, or in crates. When using sacks, it is best to pile them in pairs, lay them crosswise in stacks five or six high, and set them a few inches off the floor on wooden strips unless the floor is of special construction. A floor of narrow planks with air spaces in between allows for direct stacking. The individual stacks should be separated by a few inches of space to permit air circulation. Storing in bulk is the least satisfactory method of storage, whereas crates containing 1 bushel, or 56 pounds, are considered the most satisfactory containers for storage.

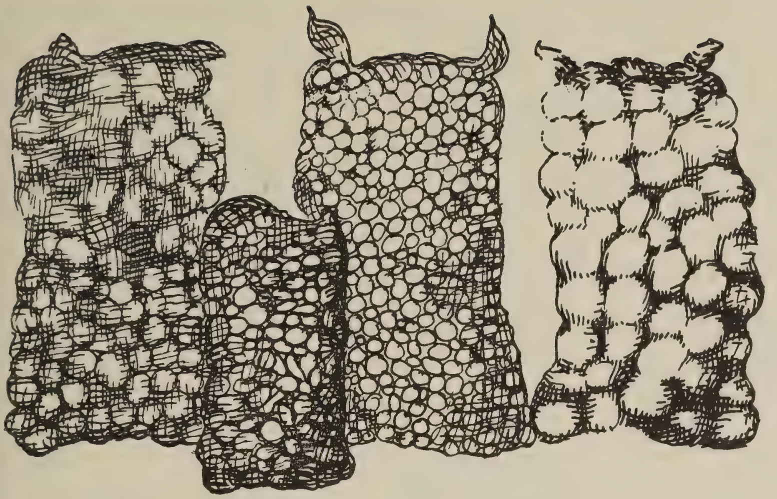


Figure 7.—Open mesh bags used in marketing onions.

c. Ventilation.—In addition to suitable containers, the successful storage f onions requires adequate ventilation, dryness, a comparatively low emperature, and safety from freezing temperature. Any building fulfilling hese conditions will suffice, but houses especially built for the purpose are most satisfactory. The best storage houses have a double wall lined with elt or paper. Provision should be made for both top and bottom ventilation nd the top openings made adjustable for temperature control.

d. Temperatures.—The temperature of the storage house should be as

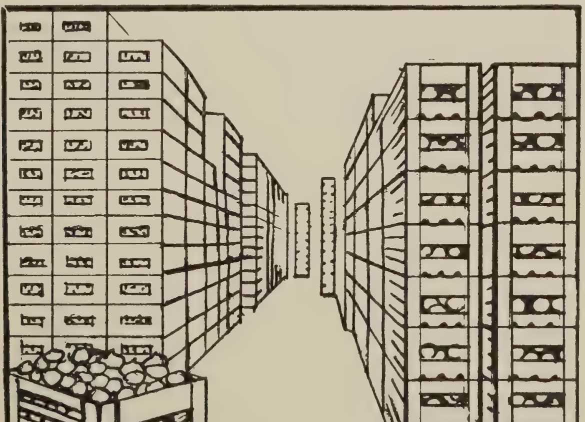


Figure 8.—Slatted crates used for storing onions.

PART V

QUICK-FROZEN FRUITS and VEGETABLES

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SECTION I

THEORY OF QUICK FREEZING

1. PRESERVATIVE QUALITIES.—*a.* The quick-freezing process completely freezes the tissues of the product by extracting heat from them as rapidly as possible. This treatment preserves the product by inactivating the enzymes and spoilage organisms which it may contain.

b. When plants are frozen slowly, large ice crystals are formed within the plant cells. As these crystals form, they withdraw moisture from the tissue of the plant and continue to grow until they burst the walls of the cells. When the plant is thawed, it deteriorates into a soggy mass because the cell structure has disintegrated and the moisture of the tissues has been released as free water. Quick freezing, on the other hand, prevents the formation of large ice crystals. Maximum crystallization takes place at temperatures between 25° and 31° F., and rapid freezing cools the product below 25° F. before the ice crystals have a chance to grow. Because they remain microscopic in size, the crystals do not noticeably affect the texture of the thawed product. More of the natural characteristics of fruits and vegetables are retained by quick freezing than by any other preservative process.

SECTION II

COMMERCIAL QUICK-FREEZING PROCESSES

2. GENERAL.—There are three common commercial quick-freezing processes: cold-air freezing, direct-immersion freezing, and indirect-contact freezing. The type of process to be applied to any product depends upon the condition of the product when it arrives at the processing plant, its freezing characteristics, and its ultimate use. Each of these factors must be considered in the light of the processing costs which the product will bear.

3. COLD-AIR FREEZING.—*a. Tunnel system.*—In this system, the product to be frozen passes through a tunnel on a long, slow-moving mesh belt. The air in the tunnel is held at a temperature between 0° and 20° F., and fans force a cold blast of air against the food as it passes through. The speed of the carrying belt is regulated to hold the product in the tunnell until the freezing process is completed. In some cases the food is placed on wire-mesh trays and carried through the tunnel on small trucks. The tunnel system of freezing has two disadvantages: the violent flow of air may cause the product to lose an excessive amount of moisture during the freezing process, and an undue amount of time is lost in the frequent defrosting of the equipment.

b. Vibrating-shelf system.—A second type of freezer likewise uses cold air as the freezing agent, but passes the product along a series of vibrating shelves. The freezer is composed of two units, one larger than the other, with each unit consisting of a number of vibrating shelves arranged in tiers. When food is placed on the top shelf of either unit, vibration causes the product to be passed down the stairway of shelves to the bottom of the unit. The smaller unit, which is used as a prefreezer, operates in a blast of air cooled to about 25° F. The prefreezer glazes the exterior of the product with ice to reduce dehydration during the freezing process. After the food has passed through the prefreezer, it is fed to the top shelf of the larger freezing unit. Here the product is subjected to a blast of air at —25° F. By the time the food reaches the bottom of the unit, the freezing process is complete.

4. DIRECT-IMMERSION FREEZING.—*a. General.*—This process freezes packaged or unpackaged products by immersing them in a refrigerating liquid. The liquid must be edible and must remain frozen at temperatures up to 0° F. Solutions of sugar and glycerol are most commonly used. Fruits frozen in a sugar sirup acquire thereby an iced coating, which preserves the color and flavor of the product during storage. More-

over. the rate of freezing is rapid because direct contact between the product and the refrigerating medium assures efficient heat transfer. However, t is quite difficult to make a sugar sirup which will remain freely fluid at the required freezing temperatures.

b. Spray freezing.—More commonly known as the "Z" process, the spray-freezing system is a variation of direct-immersion freezing. The product is sprayed with an atomized refrigerant delivered at temperatures of 10° to 12° F. A 50 percent invert sugar solution is used as the refrigerant.

c. Taylor freezer.—In the Taylor freezer, a conveyor carries the product through a circulating, refrigerated solution. Once again, efficient heat transfer results in exceptionally fast freezing.

5. INDIRECT-CONTACT FREEZING.—*a. General.*—In the indirect-contact process, the product is frozen by placing it on a metal surface cooled by some refrigerant. Variations in freezing requirements have led to the development of several types of freezer.

b. Double-belt freezer.—Two endless, noncorroding metal belts are placed one above the other in a freezing tunnel. They run at the same speed and in the same direction. The product is placed between the belts so that it makes contact with both of them. A refrigerating brine is sprayed on the reverse sides of the two belts. Thus the cold belts extract heat from the top and bottom of the product.

c. Birds Eye multiple freezer.—The Birds Eye freezer consists of 6 to 10 refrigerated metal plates tiered vertically as a freezing unit. The refrigerant flows through the hollow interior of the plates, which are actuated by hydraulic pressure so that the space between them may be varied. They are opened to permit loading of the product between them, then closed to bear upon the product with any pressure desired. This method is primarily designed for freezing foods in the package in which they are to be marketed.

d. Murphy freezer.—The Murphy freezer is used to freeze either packaged or loose products. It consists of an insulated chamber in which coils of tubing are arranged to form shelves, one above the other, in a staggered formation. The product is loaded upon the coil shelves. Refrigerant flowing through the tubes freezes the product from the bottom. In addition, blower fans placed at the ends of the insulated chamber insure more rapid freezing by keeping the cold air in motion.

e. Birds Eye gravity froster.—This freezer was developed for the continuous quick freezing of loose products. Twenty circular, horizontal, refrigerated plates are placed in tiers, inside an insulated cabinet. Each plate contains a radial hole through which the product drops to the next plate in its passage through the froster. A vibratory hopper feeds the product into the machine. As the food falls upon the top plate, a scraper moves it to the radial hole and it drops to the plate below. When the food has passed from plate to plate through the machine, the freezing process is complete.

QUICK FREEZING OF VEGETABLES

6. ADAPTABILITY TO FREEZING.—More than 30 different vegetables have been successfully frozen; vegetables which are eaten uncooked, however, do not yield palatable frozen products. Tomatoes, cucumbers, celery, radishes, and lettuce are more desirable in a crisp condition. Freezing wilts these vegetables, making them flabby and unattractive. The quality of the frozen product is dependent not only on the process employed, but also on the variety, maturity, and freshness of the vegetable. The quality is also affected by the soil and climate in which the vegetable is grown.

7. PREPARATION PROCEDURES.—*a. Steps in preparation.*—After harvesting, certain steps are taken to prepare the vegetables for freezing.

(1) Washing.
(2) Sorting.
(3) Trimming.
(4) Cutting.
(5) Blanching.
(6) Cooling in running water or water sprays at a temperature of 45° to 50° F.
(7) Packaging (this step is not included in the preparation if the vegetable is to be frozen unpackaged).

b. Illustrations.—The steps indicated above are illustrated in figures 1 through 10 as performed on a laboratory scale.

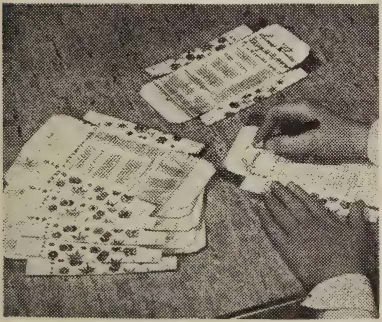

Figure 1.—Labeling package prior to freezing.

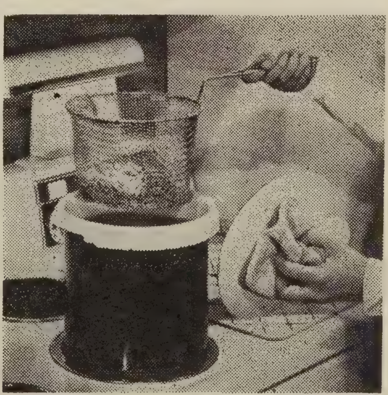

Figure 2.—Lima beans in wire basket above blanching water.

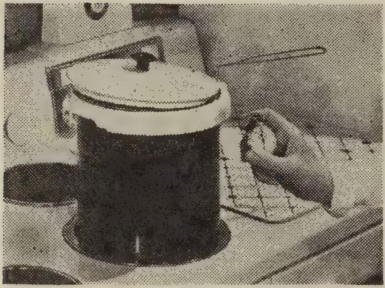

Figure 3.—Timing the blanching process.

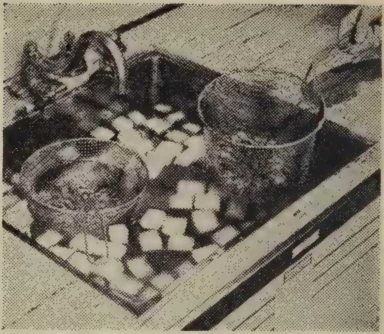

Figure 4.—Cooling the beans in ice water after blanching.

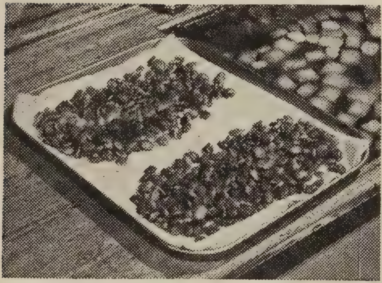

Figure 5.—Draining the vegetables on a tray after cooling.

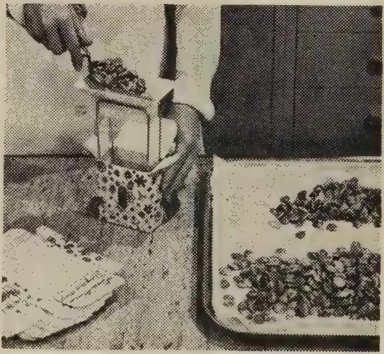

Figure 6.—Filling carton with the aid of a carton filler.

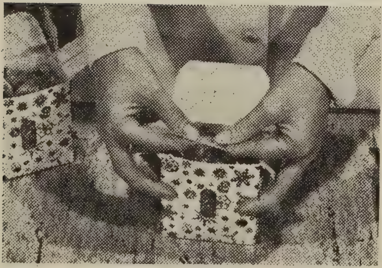

Figure 7.—Closing the cellophane bag.

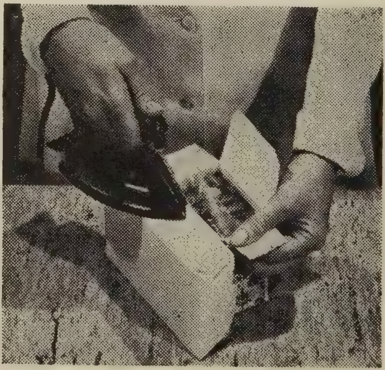

Figure 8.—Sealing the cellophane bag.

Figure 9.—Shallow sleeve of the small freezer.

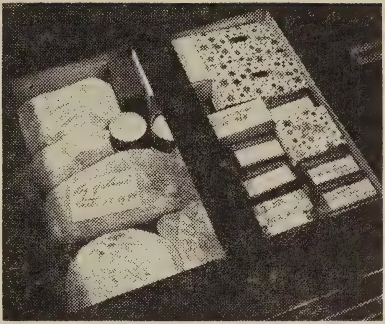

Figure 10.—Sleeve of small freezer.

c. Speed of operations.—Speed is important in every phase of preparation. If vegetables cannot be processed immediately after harvesting, they should be cooled rapidly to 40°. Otherwise, they will quickly lose much of their flavor, color, and vitamin content.

d. Blanching.—Blanching is essential to successful quick freezing. It inactivates the enzymes responsible for deterioration in quality, and it preserves the natural color of the vegetable. Furthermore, blanching destroys some of the spoilage microorganisms and inhibits the development of off-flavors during cold storage. Either steam or hot water may be used for blanching, but the use of steam is recommended, since it removes less of the soluble nutrients from the vegetable.

e. Packaging.—The blanched and cooled vegetables are carefully filled or hand-packed in paperboard containers of different sizes and shapes. In all types of containers, a cellophane liner or bag is of importance in retarding or preventing moisture loss.

8. PHASES OF PROCESSING.—The following paragraphs contain specific processing details for those vegetables which are commonly frozen commercially: the varieties of each vegetable favored for freezing; the degree of maturity to be reached before harvesting; preparation of different vegetables for freezing; recommended freezing and storage conditions; and finally, where available, the Federal Standards that apply to the frozen vegetable.

9. ASPARAGUS.—*a. Varieties.*—The green varieties, Martha Washington and Mary Washington, are best suited to quick freezing.

b. Maturity.—Asparagus is harvested between April and June. To be sufficently mature for freezing, it must have a uniform, green color and tender, succulent stalks which are free from woodiness.

c. Preparation.—(1) The harvested asparagus is washed, trimmed, and cut into the following lengths:

(a) Spears (3¾ to 6 inches).

(b) Tips (2¾ to less than 3¾ inches).

(c) Points (less than 2¾ inches).

(d) Cuts (cut portions which, by count, contain at least 15 percent heads).

(e) Bottom cuts (cut portions which, by count, contain less than 15 percent heads).

(2) After they are inspected, the cut stalks are sorted into small, medium, and large sizes. Then they are steam-blanched from 3½ to 5 minutes and cooled rapidly in running water.

d. Freezing and storage.—Asparagus is packed into cartons and frozen. It should be stored at temperatures no higher than 0° F.

e. Final inspection.—Inspection of frozen asparagus shall conform with the requirements of the United States Department of Agriculture, "Tentative United States Standards for Grades of Frozen Asparagus."

10. GREEN BEANS.—*a. Varieties.*—Kentucky Wonder, Blue Lake, Low's Champion, and Mosiac Resistant Refugee are superior freezing varieties.

b. Maturity.—Green beans to be used for freezing are harvested between June and October, when they are young and tender, of good green color, and free from fiber in their side walls.

c. Preparation.—After harvesting, the beans are snipped on a rotary bean snipper and sorted according to size in a mechanical bean grader. The usual grades are indicated below:

Grade	Size
No. 1	Less than 8/64 inch in diameter (usually discarded)
No. 2	8/64 to 11/64 inch
No. 3	11/64 to 14/64 inch
No. 4	14/64 to 18/64 inch
No. 5	Greater than 18/64 inch

The beans are washed thoroughly, cut crosswise into pieces about 1 inch in length, and blanched for 2 to 4 minutes. The larger-sized beans (No. 4 and No. 5) may be cut "French style"—*i. e.,* sliced lengthwise—either before or after blanching.

d. Freezing and storage.—The beans are frozen loose or in packages and stored at temperatures no higher than 0° F.

11. LIMA BEANS.—*a. Varieties.*—The Henderson Bush (thin seed) and the Fordhook (thick seed) beans are the varieties most commonly frozen.

b. Maturity.—Lima beans selected for freezing are harvested when they are young and tender. They should have a uniform, green color and a normal flavor and odor.

c. Preparation.—The harvested beans are shelled and washed, and then blanched in water or steam for 2 to 3 minutes. Then they are cooled in running water and conveyed to a quality grader where overmature beans, skins, and split beans are removed.

d. Freezing and storage.—The beans are frozen loose or in packages and stored at temperatures no higher than 0° F.

e. Final inspection.—Inspection of frozen lima beans shall conform with the requirements of the United States Department of Agriculture, "United States Standards for Grades of Frozen Lima Beans."

12. BROCCOLI.—*a. Variety.*—Italian green sprouting broccoli is one of the varieties favored for freezing.

b. Maturity.—The broccoli selected for freezing should be harvested between September and December, before the buds open. The heady stalks of the plant should be dark green in color and free from stringiness.

c. Preparation.—After broccoli is harvested, it is washed carefully in tanks and under sprayers to remove all dirt, aphids, and other insects. The product is then blanched from 3 to 5 minutes and cooled in running water.

d. Freezing and storage.—Broccoli is packaged, frozen, and stored at temperatures not exceeding 0° F.

e. Final inspection.—Inspection of frozen broccoli shall conform with the requirements of the United States Department of Agriculture, "Tentative U. S. Standards for Grades of Frozen Broccoli."

13. BRUSSELS SPROUTS.—*a. Varieties.*—The Half Dwarf Improved and the Long Island Improved brussels sprouts are superior freezing varieties.

b. Maturity.—Brussels sprouts mature between October and December. Sprouts selected for freezing should be evenly matured, firm, of medium size, and deep green in color.

c. Preparation.—The sprouts are harvested, washed, inspected, and trimmed. Then they are graded, blanched from 3 to 5 minutes, and cooled quickly in running water.

d. Freezing and storage.—Brussels sprouts are frozen loose or in packages, and stored at temperatures not exceeding 0° F.

14. CAULIFLOWER.—*a. Varieties.*—The Forbes, Snowball, White Mountain, and Perfection varieties are suitable for freezing.

b. Maturity.—Cauliflower matures between September and October. The cauliflower selected for freezing should have compact, smooth heads with tender white curds.

c. Preparation.—After the heads are harvested, they are trimmed and cut to uniform size. The heads are then blanched 3 to 5 minutes and cooled rapidly. All these operations must be done quickly, for the cut surfaces of the heads soon develop a pink or brownish color when exposed to air.

d. Freezing and storage.—The cauliflower is packaged, frozen, and stored at temperatures not exceeding 0° F.

e. Final inspection.—Inspection of frozen cauliflower shall conform with the requirements of the United States Department of Agriculture, "Tentative U. S. Standards for Grades of Frozen Cauliflower."

15. CORN.—*a. Varieties.*—Golden Cross Bantam and Golden Bantam are the only varieties of sweet corn that are packed extensively.

b. Maturity.—The maturity of the corn selected to be frozen is another important factor in controlling the quality of the product. Corn should be harvested when the kernels are fully rounded, well colored, and in the full-milk stage.

c. Preparation.—Speed is imperative in preparing sweet corn for freezing, as its sugar content is lost rapidly after harvesting. Husking the corn, a process that removes the protective leaves from the ears, is followed by thorough washing to remove the silks and the ribbons of husks that may be lodged between the rows of kernels. The ears that are at exactly the right level of maturity are sorted by sizes, steam-blanched from 6 to 9 minutes, and rapidly cooled; the rest of the ears, which are off grade in maturity or irregular in size, are conveyed to the corn cutter, where the kernels are removed from the cob. The kernels are blanched from 2½ to 3 minutes and cooled quickly.

d. Freezing and storing.—Cut corn is frozen loose or in packages; corn on the cob is put into moistureproof envelopes and frozen, either packaged or unpackaged. Frozen corn is stored at temperatures not exceeding 0° F.

e. Final inspection.—Inspection of frozen corn shall comply with the requirements of the United States Department of Agriculture, "Tentative United States Standards for Grades of Frozen Corn."

16. PEAS.—*a. Varieties.*—Thomas Laxton, Dark Podded Thomas Laxton, Alderman (Type Telephone), and Gradus peas are the varieties

preferred for freezing. They are superior to the varieties commonly used for canning, such as the Surprise and the Perfection. The freezing varieties are of a dark-green color, are larger in size than the canning varieties, and have a more distinct flavor.

b. Maturity.—Peas selected for freezing are harvested between June and September, at the optimum stage of their maturity. Within a few days thereafter, the natural sugars of the growing peas may turn into starch as the plant ripens. Peas should be harvested while they are still tender and sweet and possess a fine flavor.

c. Preparation.—After harvesting, peas are shelled and cleaned, and then tested for maturity. Then they are washed thoroughly and blanched in steam or water for 50 to 90 seconds, the time varying with the temperature, the blanching system used, and the maturity of the peas. The blanched peas are cooled and flumed to a quality brine grader where overmature peas sink and are removed. They are then inspected carefully and split peas, skins, and off-colored peas removed.

d. Freezing and storage.—Peas are frozen loose or in packages and stored at temperatures not exceeding 0° F.

e. Final inspection.—Frozen peas shall conform to the requirements of

Figure 11.—Frozen rhubarb.

the United States Department of Agriculture, "United States Standards for Grades of Frozen Peas."

17. RHUBARB.—*a. Varieties.*—The deep-red varieties, such as the Strawberry, Ruby, and MacDonald, are most suitable for freezing.

b. Maturity.—Rhubarb selected for freezing should be harvested between April and June, while the stalks are succulent. Overmaturity results in coarseness and woodiness.

c. Preparation.—After the rhubarb is washed thoroughly, the butt ends are trimmed off and the stalks cut into specified lengths. Rhubarb is not always blanched, but the blanched product is said to keep better in storage. If it is blanched, a time limit of 90 seconds is recommended.

d. Freezing and storage.—The cut rhubarb is packaged, frozen, and then stored at temperatures not exceeding 0° F.

18. SPINACH.—*a. Varieties.*—Virginia Savoy, Nobel, and King of Denmark are the best varieties for freezing.

b. Maturity.—There are two crops of spinach, one maturing in the spring, the other in the fall. Because of its superior quality, the spring crop is the source of most spinach selected for freezing. It is harvested when the leaves are of a dark-green color and have a tender midrib.

c. Preparation.—The spinach is sorted to remove all defective leaves. The remaining leaves are washed, blanched from 2 to 4 minutes, and thoroughly cooled.

d. Freezing and storage.—The spinach is packaged, frozen, and stored at temperatures up to 0° F.

SECTION IV

PREPARATION OF FRUITS FOR QUICK FREEZING

19. GENERAL.—After reaching prime condition, fruits deteriorate rapidly. The chief advantage of preserving fruits by freezing is that their freshness is better retained. Under proper storage conditions, the flavor, color, and texture of frozen fruits can be maintained for many months.

20. RISKS AND PRECAUTIONS.—The preliminary steps in the freezing of fruits are more complicated than those employed in the freezing of vegetables. Freezing causes radical changes in the appearance, texture, flavor, and color of fruits. Blackberries turn brown and become soft and flavorless; strawberries when thawed become extremely flabby and lose a portion of their juice; peaches, apples, and other fruits containing tannins, darken during preparation and after thawing; raspberries, blueberries, and plums become soft and lose much of their flavor and aroma. The cranberry is the only fruit requiring no special treatment to preserve its natural texture, color, and flavor during the processes of freezing and thawing. Most fruits must be packed in sugar or sirup, or given some other special treatment, if they are to be frozen satisfactorily.

21. SELECTION OF FRUITS.—Fruits to be frozen should be riper than those selected for canning. Unripe fruits do not yield frozen products of good quality; on the other hand, overripe fruits become mushy and

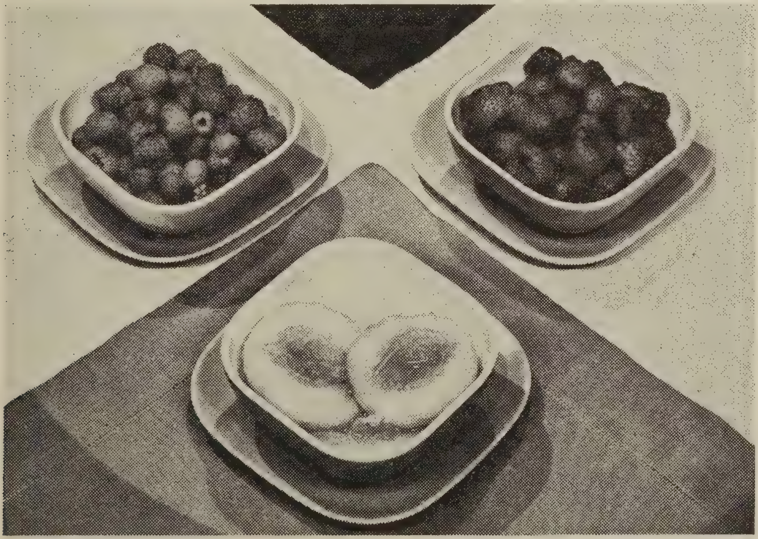

Figure 12.—Frozen fruits (raspberries, peaches, and strawberries) ready for serving.

unappetizing when frozen and thawed. Fruits ripened on the tree or vine have a better flavor and color than those packed when immature and ripened in storage.

22. VARIETIES ADAPTED TO FREEZING.—The selection of fruit varieties suitable for freezing is an important factor in obtaining a superior frozen product. These varieties are affected by the soil and the climatic conditions in which the fruits are grown. Therefore, a single variety will differ in quality, depending on the region in which it is produced. The table, Fruit Varieties Suitable for Freezing, indicates a few varieties of fruits from different sections of the United States, which can be satisfactorily frozen.

23. PREPARATION PROCEDURES.—*a. Classification for freezing.*—Fruits to be frozen may be divided into two general classes:

(1) Small fruits such as strawberries, currants, and raspberries. These can be cleaned and prepared whole without excessive injury to the skin and leakage of juice.

Figure 13.—Frozen raspberries.

FRUIT VARIETIES SUITABLE FOR FREEZING

Fruit	New York	Middle Atlantic States	Tennessee	Northwest Pacific
Apples	Rhode Island Greening Baldwin Northern Spy Winesap Stark		Golden Delicious Grimes Golden Jonathan Rome Beauty Winesap	Yellow Newton Winesap Spitzenberg Jonathan
Blueberries	Concord Rubel Pioneer Rancocas Cabot	Pioneer Cabot Concord Rubel Rancocas		Rancocas June Concord Katherine Jersey
Cherries	Montmorency English Morello			Montmorency English Morello
Cranberries	Early Black Hawes			McFarlin Hawes Centennial
Currants	Red Lake Perfection			
Grapes			*Muscadine Varieties* Thomas San Jacinto Irene	*Vinefera Varieties* Muscat of Alexandria Thompson Seedless Muscat Hamburg
Peaches	Halehaven South Haven J. H. Hale Elberta Ideal	Chairs J. H. Hale Reeves Up-to-date Saint John	Crawford Early Elberta Eclipse Elberta Georgia Belle	J. H. Hale Condoka Gold Medal Late Crawford Elberta
Plums	Red Wing Damson Yellow Egg		Damson Gold Methley Wild Goose	
Prunes	Italian German Stanley Imperial Epineuse			Italian French
Raspberries (red)	Cuthbert Viking Taylor Lloyd George	Latham Cuthbert Chief Ranere	Chief Latham Ranere	Cuthbert Takama Lloyd George
Strawberries	Culver Catskill New Jersey 225 Dunlap Clarmont	Bellmar Blakemore Chesapeake Howard Supreme Klondike	Blakemore Klondike Dorsett Missionary Premier	Corvalis Marshall Clark Seedling Redheart Wray Red

(2) Fruits which should be pitted and peeled, such as peaches, cherries, and apples. These must be processed carefully, for the cut surfaces oxidize quickly when exposed to the air.

b. Addition of sugar.—The addition of sugar or sugar sirup in preparing fruits for freezing has a three-fold purpose:

(1) It prevents oxidation and enzymatic activity in the fruit.

(2) It reduces the evaporation of the more volatile esters and other compounds that give fruits their characteristic flavor and aroma.

(3) It improves the flavor of sour fruits by penetrating the tissues during the processes of freezing, storage, and thawing.

24. PACKING AND FREEZING.—*a. Dry pack.*— (1) *Without sugar.*—Fruits which are dry-packed without sugar require very little

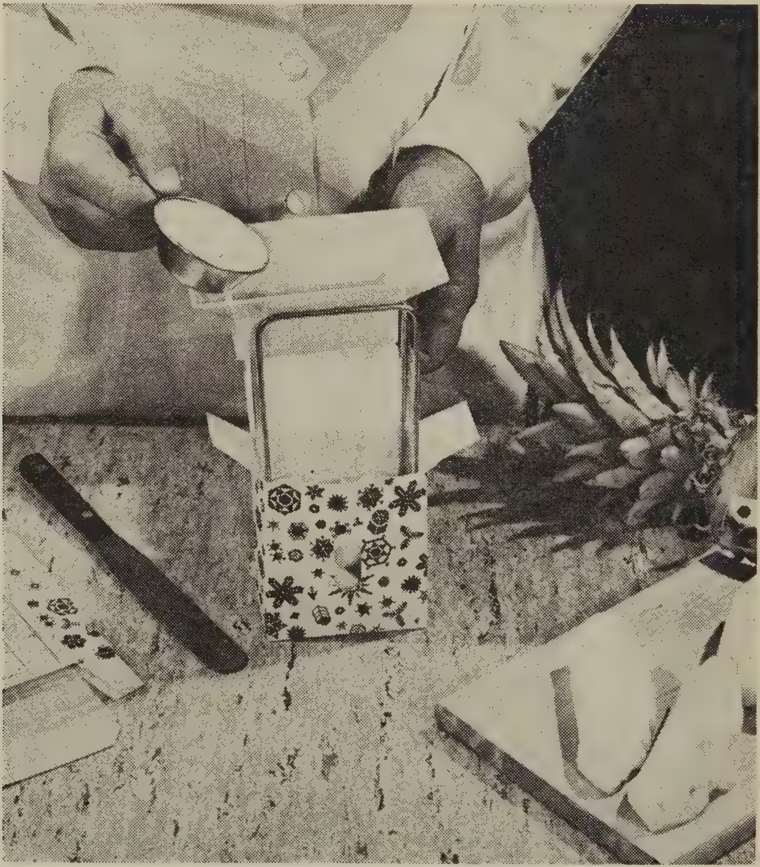

Figure 14.—Pineapple with sugar.

treatment. First the fruits are sorted, cleaned, and washed; then they are well drained to prevent their freezing into a solid mass. Fruits packed in this manner are usually preferred for use in pies, preserves, jellies, and juices.

(2) *With sugar.*—Dry-packing fruits with sugar is the oldest of the methods in common use today. The fruits are cleaned, washed, and packed with sugar. The fruits to be packed may be whole, sliced, chopped, or crushed. Ordinarily, 1 pound of sugar is added to every 3 or 4 pounds of fruit. The sugar and fruit are well mixed, so that the fruit is thoroughly coated with the dissolved sugar. Fruits for all purposes may be packed by this method, but they are especially desirable for use in desserts.

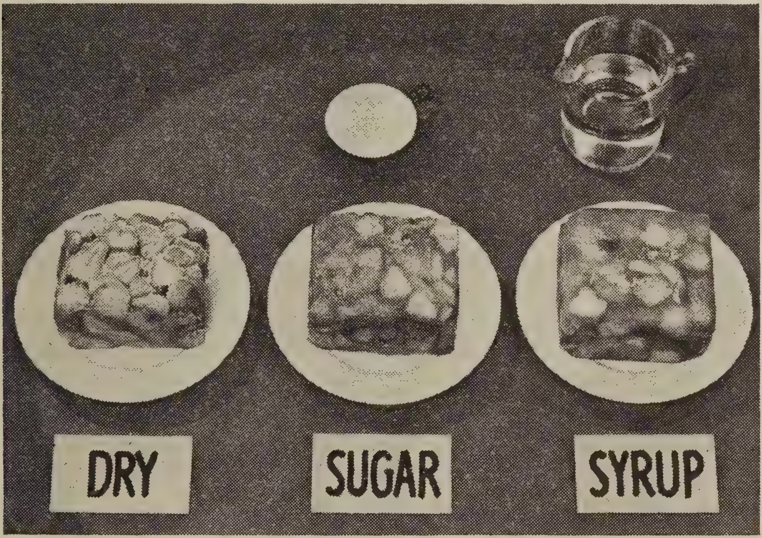

Figure 15.—Frozen strawberries with cellophane removed, processed in three different ways.

b. Sirup pack.—Packing fruits in sirup is the most practical method of retarding oxidation and preventing the loss of original color. All fruits in whole, sliced, chopped, or crushed form may be packed by this method. A 40 to 60 percent solution of cool, heavy sirup is added to the fruit, the exact strength varying with the fruit's acidity. The packaged fruits are allowed to stand from 1 to 2 hours, thus permitting the sirup to penetrate their tissues.

c. Quick freezing.—After packaging, the fruits are quick-frozen by one of the commercial processes described in section II and stored at a temperature not exceeding 0° F.

SECTION V

PACKAGING

25. PACKAGE REQUIREMENTS.—Frozen foods must be packaged properly to assure a satisfactory finished product. Packaging materials are subjected to rigid tests to determine the suitability of their protective properties. The package must be made of a moistureproof, greaseproof, odorless, tasteless, and noncorrosive material that can be completely sealed. The package must prevent desiccation of the enclosed food, protect the food from contamination, and prevent the absorption of outside odors and flavors.

26. COMPONENTS OF THE PACKAGE.—*a. General.*—A package normally consists of a carton, an inner lining, and an overwrap. The frozen-food industry has attempted to standardize these components of the package, but complete standardization has not yet been achieved.

b. Cartons.—(1) *Material.*—Carton blanks are cut from a good grade of paper stock made of bleached sulfite or white patent-coated manila.

(2) *Form.*—Cartons are usually rectangular in shape because this permits the easy packing of all fruits and vegetables. Furthermore, rectangular-shaped cartons may be packed in shipping containers and storage rooms with little loss of space.

(3) *Treatment.*—Carton blanks are treated with paraffin wax by either the cold-wax or the hot-wax process.

(a) Cold-wax process.—The blank is submerged in a molten-wax bath, and then immersed in cold water to congeal the wax and prevent its penetration into the fibers of the paper.

(b) Hot-wax process.—The blank is submerged in the molten wax but is not cooled immediately. Thus the wax is allowed to penetrate into the fibers.

(4) *Weights.*—The net weights of the contents of the cartons are more uniform than are the shapes and sizes of the carton. Three classes are in general use, each having a standardized weight.

(a) Retail pack.—10, 12, and 16 ounces.

(b) Institutional pack.—2½ to 5 pounds (at ½-pound intervals).

(c) Processor pack.—30, 40, 50, and 100 pounds.

c. Liners.—The use of liners within the carton is optional with the processor. The liner should be made of waterproof and moisture-vaporproof materials, and should remain flexible under low storage temperatures for long periods. Liners are usually made of special grades of cellulose, vegetable parchment, sulfite paper, pliofilm, or glassine.

d. Overwraps.—After the cartons are packaged, they are usually overwrapped with wax paper or cellophane. When the overwrap is made of moisture-vaporproof material, it helps to protect the food from desiccation and oxidation.

SECTION VI

STORAGE

27. TEMPERATURE.—Frozen foods must be stored at low temperatures to prevent the deterioration and spoilage that might be caused by enzymic activity and bacterial growth. Although a large percentage of bacteria is destroyed by the freezing process, many remain alive and become active at warmer temperatures. Experience has shown that most frozen foods may be kept in a satisfactory condition at 0° F. Some foods, such as asparagus, snap beans, and mushrooms, require a lower temperature.

28. STORAGE PROCEDURES.—Frozen food is packed in corrugated fiberboard shipping cases for storage and subsequent handling. Cases of food should be stacked so that good air circulation is maintained. Dunnage should be laid on the floor, below the first layer of cases, and additional dunnage should be placed between the cases at intervals of two or three courses. Under proper storage conditions, cases are not stacked close to the wall, and aisles are spaced at regular intervals.

SECTION VII

TRANSPORTATION

29. TRANSPORTATION PROCEDURES.—When frozen foods are shipped, they must be held in their original frozen condition, no matter how long they are in transit. Partial thawing and subsequent refreezing are detrimental to the quality of the frozen food. Frozen foods are usually transported in refrigerated cars and trucks. The temperature of the cases of food must not be above 0° F. when placed in the refrigerated vehicle. The temperature of the car or truck should not exceed 10° F. at any time in transit. Ice, salt and ice combined, mechanical refrigeration, and dry ice are used to maintain the proper refrigerated temperature. The salt-and-ice mixture has been satisfactory and economical for use with refrigerator cars, but dry ice is most commonly used in refrigerator trucks.

SECTION VIII

MESS PREPARATION

30. HANDLING AND STORAGE.—*a. Special treatment.*—Frozen foods cannot be handled in the mess exactly as if they were fresh foods. Unless they receive special care, frozen foods will be unappetizing by the ime they are served. They should be kept frozen until shortly before use. Fruits become mushy, turn dark, and develop off-flavors if they are not served immediately after thawing. Likewise, thawed vegetables gradually ose their bright color and fresh flavor, even though they are kept cool.

b. Temporary storage.—Frozen fruits and vegetables must be kept in a refrigerator. The length of time they can be kept satisfactorily depends on the temperature of the refrigerator. If the food thaws, it should be cooked and served promptly.

c. Washing.—Washing of frozen foods is unnecessary, since they have been carefully cleaned and washed before being packaged. Frozen foods should not be thawed in water, because the water removes a large part of their flavor and nutrients.

31. PREPARATION OF FRUITS.—Fruits that have been frozen without sugar or sirup should be handled in the frozen state if they are to be used in the preparation of pies, sauces, or puddings. If they are to be served for dessert without cooking, the fruits should be removed from the containers and covered with sugar while still frozen. Fruits frozen with sugar or sirup should be thawed in one of the following ways before opening the container:

a. At room temperature.
b. In a refrigerator.
c. Before a fan blast of air at room temperature.
d. By immersing the closed package in running water.

32. PREPARATION OF VEGETABLES.—*a. Cooking.*—Most fresh and frozen vegetables are prepared in much the same manner, except that frozen food requires a shorter cooking time. Overcooking is one of the most common faults in the preparation of frozen vegetables. They require approximately half as much cooking as the fresh variety. The consistency and texture of most frozen vegetables deteriorate rapidly on a steam table; therefore, they should be cooked just before serving. Thawing the vegetables before cooking is unnecessary. The contents of the package are simply placed in a pan with a small amount of boiling water. The boiling time is measured from the point when the water reaches a boil for the second time.

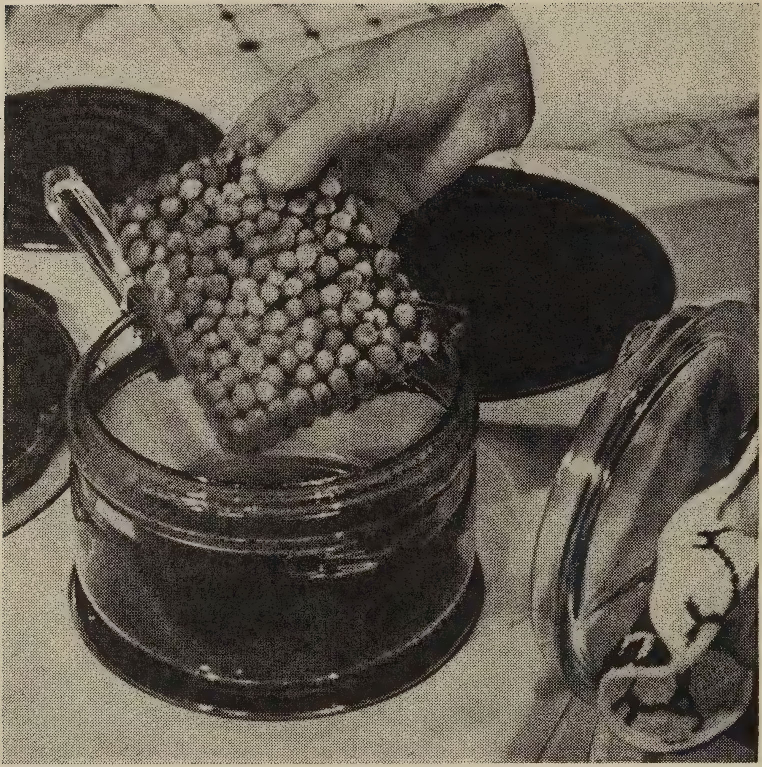

Figure 16.—Frozen peas cooked directly from the frozen state. With this method color retention is excellent.

b. Corn on the cob.—Prior to cooking, the corn should be thawed in the container at room temperature. It should be heated through, but not cooked long enough to soften the cob and make it soggy.

c. Asparagus.—Asparagus in the container should be thawed at room temperature until the stalks are soft enough to be broken apart. The tips of asparagus are more tender than the butts; therefore, in cooking, the tips should be standing out of the boiling water so that the stalk will be evenly cooked.

SECTION IX

NUTRITION AND QUALITY CONTROL

33. NUTRITION.—*a. Vitamin content.*—The study of the nutritive properties of frozen fruits and vegetables has been concerned primarily with vitamin stability. Comparative analysis of fresh, canned, and frozen foods ready for eating indicates that frozen foods are superior to canned foods in vitamin content. Furthermore, frozen fruits and vegetables compare favorably with the fresh products obtained in the open market.

b. Vitamin losses.—Vitamin C is very unstable and is readily destroyed by oxidation. Nearly 30 percent of the vitamin C content of peas is lost n preparing them for freezing. However, after peas have been frozen and stored properly, the vitamin loss is very slight. Therefore, frozen products that retain a high vitamin C content reveal good quality control in their preparation. Vitamins A, B_1, and B_2 are destroyed only to a small degree by freezing.

34. QUALITY CONTROL.—The quality and nutritive values of frozen foods are dependent on the degree of quality control practiced in the freezing operations. To test the care and skill with which frozen foods have been prepared, bacterial plate counts are taken. A low plate count indicates that the product has been prepared and frozen under sanitary conditions, and that it has not been defrosted during storage or shipment. The blanching process should inactivate certain enzymes—namely, catalase and peroxidase. A negative test for these enzymes indicates that blanching has been thorough, so that the frozen food will not lose color or develop off-flavors if stored at a temperature of 0° F. Destruction of the enzymes preserves the vitamin content of the vegetables.

35. FEDERAL STANDARDS.—The quality of frozen foods is controlled by standards issued by the United States Department of Agriculture, and by specifications issued by the Quartermaster Corps.

a. United States Standards.—United States Standards define the grades of vegetables according to their color, percentage of allowable defects, degree of tenderness, maturity, uniformity of size, and flavor.

b. Quartermaster Corps Tentative Specifications.—Quartermaster Corps Tentative Specifications prescribe the conditions which the producer must satisfy to produce an acceptable product. The specification indicates the variety of the fruit or vegetable, and the operating conditions that must be conformed to in the freezing, packaging, and storing of the product.

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